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**EXPERIMENTAL AERODYNAMIC CHARACTERISTICS  
OF MISSILES WITH SQUARE CROSS SECTIONS**

**TECHNICAL NOTE  
USAFA-TN-83-8**

**UNITED STATES AIR FORCE ACADEMY**

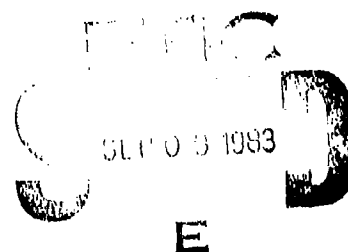
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**15 MAY 1983**

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## ACKNOWLEDGEMENTS

THE AUTHORS WISH TO EXPRESS THEIR APPRECIATION TO APPROXIMATELY 30 US AIR FORCE ACADEMY CADETS FOR THEIR ASSISTANCE IN OBTAINING, RECORDING, AND ANALYZING MUCH OF THE DATA IN THIS REPORT. IN ADDITION, WE ARE INDEBTED TO OUR COLLEAGUE MAJ. THOMAS BOLICK WHO PROVIDED THE SOFTWARE SUPPORT, AND THE US AIR FORCE ACADEMY AERO LABORATORY TECHNICIANS WHO PROVIDED THE TECHNICAL SUPPORT.

## FORWARD

A SERIES OF QUANTITATIVE AND QUALITATIVE TESTS WERE CONDUCTED TO EXPAND THE AERO-DYNAMIC DATA BASE OF SQUARE CROSS-SECTION MISSILES. QUANTITATIVE TESTS INCLUDED MEASURING FORCES AND MOMENTS ACTING ON SQUARE MISSILES, AND MEASURING FLOWFIELD PRESSURES ON THE LEEWARD SIDE OF SQUARE MISSILES AT VARIOUS CONFIGURATIONS AND ORIENTATIONS IN A SUBSONIC WIND TUNNEL. FORCE AND MOMENT DATA IS PRESENTED SHOWING THE EFFECTS OF VARIATION IN BODY CORNER RADIUS, NOSE AND FIN SHAPES, PITCH ANGLE, AND ROLL ANGLE. FLOWFIELD PRESSURE AND CROSSFLOW VELOCITY DATA ARE PRESENTED FOR MISSILES OF VARIOUS PITCH ANGLES, ROLL ANGLES, BODY CORNER RADII, AND FINENESS RATIOS (LENGTH TO WIDTH RATIO). IN ADDITION, FLOWFIELD DATA IS SHOWN ALONG THE AXIAL LENGTH OF A SQUARE MISSILE.

QUALITATIVE TESTS INCLUDED PHOTOGRAPHING TUFT GRIDS IN THE FLOWFIELD AND PHOTOGRAPHING OIL SHEAR STRESS PATTERNS ON THE SURFACE OF VARIOUS MISSILES. THESE QUALITATIVE PHOTOGRAPHS ARE PRESENTED FOR VARIOUS MISSILE CONFIGURATIONS AND ORIENTATIONS.

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## INTRODUCTION

During the last several years there has been increasing interest in rectangular or square cross-section bodies for missiles and submunition applications. This interest is due primarily to the increased packing efficiency that results from the rectangular shape as compared to missiles with circular cross sections. This packing efficiency gain is due to two factors: (1) the ease of packing rectangular modular components and (2) greater usable volume for a given frontal area. What must be determined, however, is whether this well-recognized packing advantage is outweighed by possible detrimental aerodynamic effects.

Unfortunately, only a limited amount of aerodynamic information exists which could support preliminary design or analyses of missiles with square cross-sections, especially those requiring moderate amounts of maneuverability. These limited studies include the two-dimensional work by Polhamus (Ref. 1 and 2) which investigated with the aerodynamic characteristics of several non-circular 2-D cylinders with the longitudinal axis normal to the freestream flow. Drag, side-force and pressure coefficient variation with Reynolds number was investigated with a primary stability predictions for fuselages at high angles of attack. Additional work was conducted by Clarkson (Ref. 3) on a rectangular cross-section forebody at an angle of attack between 45 and

90 degrees. This work concentrated on investigating side-force and pressure coefficient variation with Reynolds number and the reasons for the failure of simple cross-flow theory to predict behavior at high angles of attack. Finally, Knoche (Ref. 4) and Schneider (Ref. 5) briefly investigated the aerodynamic characteristics of bodies with rectangular cross sections. In general, however, there is little in the technology base to support design of three dimensional applications.

To assist in overcoming this deficiency, the Air Force Armament Laboratory and the Air Force Academy conducted a research program to analyze the aerodynamic characteristics of missiles having square cross-sections. The first phase of the program was concerned with measuring the experimental forces and moments on square missiles for a wide range of geometries, orientations, and flow conditions. Photographic documentation of surface oil-flow patterns which define the shear stress distribution along the missile surface were also recorded. The second phase of the program was concerned with detailed flow-field measurements. Pressure measurements were recorded in various planes of the flow-field and pressure contours were mapped of the flowfield. In addition, tuft grid photographs were taken to describe the flow-field. This report presents results from each of the two phases of the research program which began in November 1979 and extended through December 1982.

## II DESCRIPTION OF EXPERIMENT

All testing was conducted at the Air Force Academy Aeronautics Laboratory using the subsonic wind tunnel. Basically, two types of quantitative tests were conducted: force and moment measurements and flowfield pressure measurements. The force and moment measurements were made using an internally mounted steady state strain gage balance in a free stream velocity of 360 ft/s and atmospheric pressure. The flowfield measurements were made using a 7-hole pressure probe mounted on a three-directional traverse mechanism. This data was taken at a free stream velocity of 100 ft/s and atmospheric pressure. In addition, two types of qualitative tests were conducted: tests to record oil flow patterns on the surface of various shaped missiles, and tests using a tuft grid matrix to record cross-flow velocity patterns on the leeward side of the missile. Oil surface tests were conducted at 360 ft/s, and the tuft grid tests were conducted at 100 ft/sec.

### 1. Wind Tunnel (Ref. 6)

The U.S. Air Force Academy subsonic wind tunnel is a continuous flow closed circuit facility which has a test section of two feet by three feet and is capable of operation between Mach numbers of 0.04 and 0.35 at atmospheric pressure. At the maximum operating condition, the tunnel is capable of operation at a unit Reynolds

number of 1.6 million per foot. The nominal turbulence level of the test section has been measured at 0.12% based upon an overall spacial average for a velocity range of 60 to 150 fps. A general schematic is presented in Figure 1.

## 2. Wind Tunnel Models

Two sets of models were tested in the experiment: one set with fineness ratio equal to 8 (fineness ratio is defined as the length to width ratio of the missile), and another set with fineness ratio equal to 16. A description of each set of models follows.

### A. Models of Fineness Ratio 8

The various model components used in this investigation are shown in Figures 2 and 3. These figures depict the four bodies, each with a different cross-section corner radius; the two noses, a blunt-tangent ogive, and pointed-tangent ogive, and one each of the three sets of fins that were used. All components were made of aluminum. As illustrated by the figure, the four body cross-sections ranged from square (B1) to round (B4) and were defined by a normalized body corner radius ratio ( $r/b$ )  $r$  being the radius of the corners and  $b$  being the diameter of the circular missile. The values investigated were 0.0, 0.1, 0.2, and 0.5. These

bodies are depicted in Figures 2 and 3 as I, II, III, and IV respectively. Each body section was 12 inches long and had a width (diameter) of 2 inches. The blunt tangent ogive nose (N1) shown in Figure 2 was 3 inches in length and had a bluntness of 0.69. The pointed-tangent ogive nose (N2) was 4 inches long. The three sets of fins were designated F1, F2, and F3, and had aspect ratios (based on exposed semi-span) of 0.47, 0.67, and 0.34 respectively. Fins F1 and F3 had an exposed semi-span of 1.25 inches and lengths of 4 inches and 6 inches respectively. Fin F2 had an exposed semi-span of 1.5 inches and a length of 3 inches. The four bodies, two noses, and three sets of fins were used to make various configurations of the missile model. An assembled model, is shown in Figure 4. As can be seen from this figure, the fins are mounted in a standard cruciform arrangement at the corners of the body.

#### B. Models of Fineness Ratio 16

The model components of the missiles of fineness ratio 16 are shown in Figure 5. This figure depicts five bodies, each with a different cross-section corner radius, and two noses, a blunt-tangent ogive and a pointed-tangent ogive. These components were also made of aluminum. Fins were not used on these high fineness ratio missiles. As illustrated in the figure, five bodies were tested and ranged from perfectly square (designated missile 1) to



perfectly round (designated missile 5). The normalized body corner radii ( $r/b$ ) values of these five bodies were 0.0, 0.1, 0.2, 0.3, and 0.5. The bodies are depicted in Figure 5 as 1, 2, 3, 4, and 5, respectively. Each of these bodies were 20 inches long and had a width of approximately 1.5 inches. The two noses, the blunt tangent ogive and the pointed tangent ogive, were 3" and 4" in length, respectively.

### 3. Force and Moment Balance

A .75 inch diameter, steady state, internally mounted strain gauge balance was used to measure the force and moment components on the square-shaped missile bodies in three axes. The balance is capable of measuring forces to an accuracy of 0.1 percent. Forces and moments were recorded in either the body or wind axis systems with the axis origin at the balance center. Figure 6 illustrates positive loads recorded by the balance and the positive force directions in the body and the wind axis systems with respect to the square missile.

### 4. Flowfield Test Measurement Apparatus

A seven hole pressure probe developed at the United States Air Force Academy was used to measure pressures on the leeward side of various missile configurations (Ref 7). The Seven-hole probe

is capable of recording total pressure, static pressure, and fluid velocity in all three axes and has been calibrated for incompressible fluid flows up to 80 degrees, measured from the flow directions to the probe axis. Figure 7 depicts the seven-hole probe used in the experiment. As shown in the figure the probe is approximately 0.1 inch in diameter. To position the probe on the leeward side of the missile body, a three-directional traverse mechanism was used. For all flow field measurements taken, the traverse mechanism was used and was positioned to place the probe in a plane behind the model. Figure 7 shows the traverse mechanism.

#### 5. Data Acquisition and Processing

All data was acquired using an Automated Data Acquisition System and a PDP 1145 computer. Raw data from either the strain gage balance or the seven-hole pressure probe were input into computerized data reduction programs which computed the force and moment coefficients illustrated in Appendix A or total pressures and velocity cross flows illustrated in Appendix C. Graphical plots were obtained using the PDP 1145 computer and a Tektronix 4662 Interactive Digital Plotter.

## 6. Qualitative Tests Apparatus

To enhance our understanding of the flow field pressure and velocity patterns obtained by the pressure probe, tuft grid tests and oil flow tests were also conducted. Tuft grid tests were conducted by placing a grid of wool tufts in the flow field and then photographing the tuft patterns. Appendix D shows the tuft grid photographs. Oil flow tests were conducted by painting the models black and then spraying white oil in a light speckled pattern on the models. The oil was a mixture of titanium dioxide, oleic acid and 90 weight transmission oil. After the tunnel was brought up to the appropriate speed and the oil migrated sufficiently over the surface of the models to define the shear stress distribution, photographs were taken of the oil flow patterns. Appendix E shows the photographs of various oil flow patterns.

## III TEST RESULTS

Results of the tests performed are illustrated in Appendices A through E. A short description of each test is presented at the beginning of each Appendix. Analysis of the data is left for the reader, although several papers (Ref. 8-10) have been published which analyze various aspects of the data. A description of the test data presented in each appendix is described below.

## Appendix

## Description of Tests Results

- A      Force and Moment Graphical comparisons of various missile configurations. Data is presented in either the body or wind axes format.
  
- B      Tabular print-outs of Forces and Moments measured on various missile configurations. Data is presented in either the body or wind axes format.
  
- C      Quantitative flowfield data. Data includes both plots of total pressure contours and cross-flow velocity vectors in a plane of the flow on the leeward side of the missile. Plane of data is perpendicular to the free stream velocity.
  
- D      Photographs of tuft grid patterns describing the flow field on the leeward side of the missile.
  
- E      Photographs of oil flow patterns on the surface of missiles tested in various configurations.

# USFA 2x3 SUBSONIC WIND TUNNEL

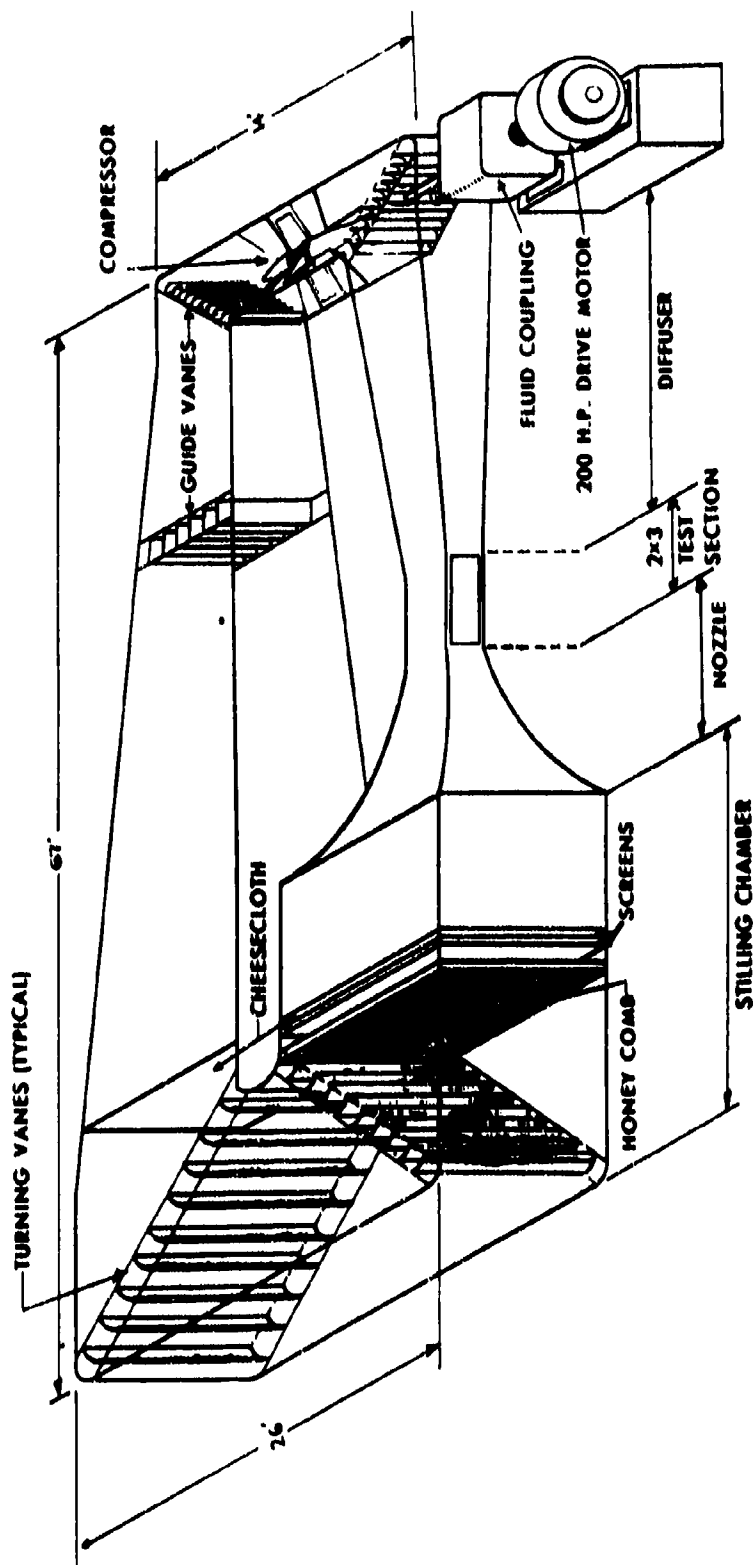


Figure 1. Wind Tunnel Schematic

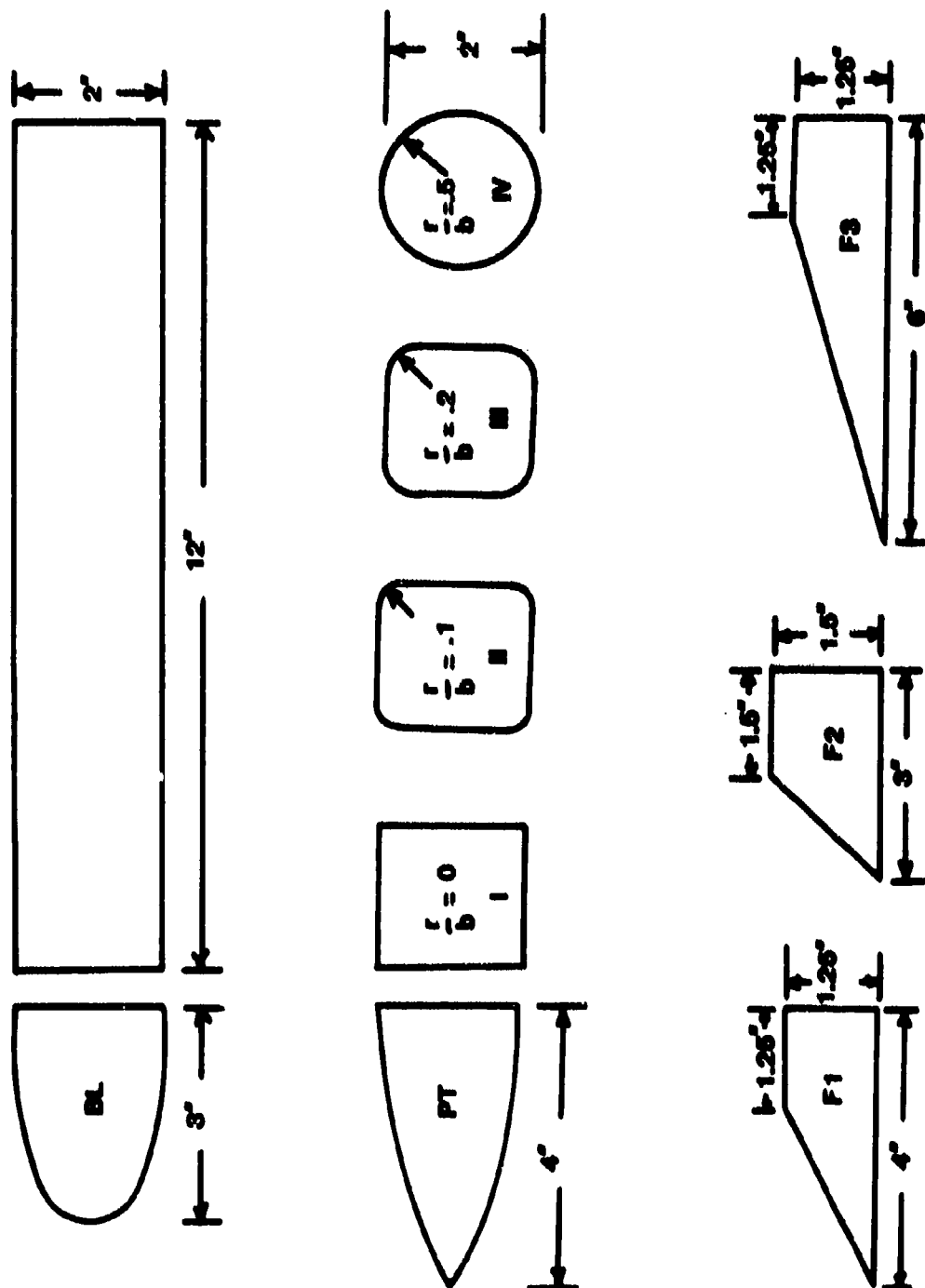


Figure 2. Components of Missile with Fineness Ratio 7.5

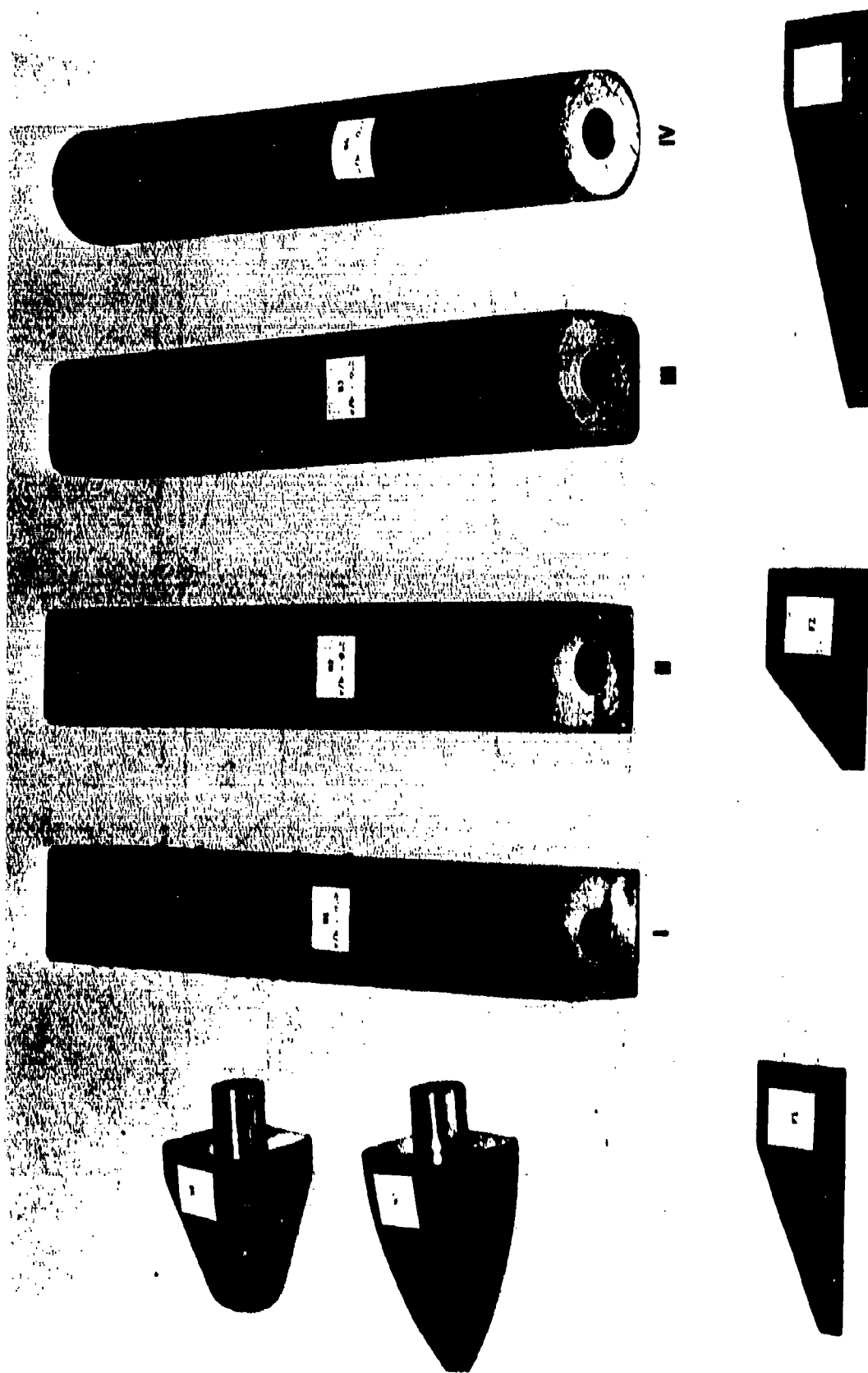


Figure 3. Model Components

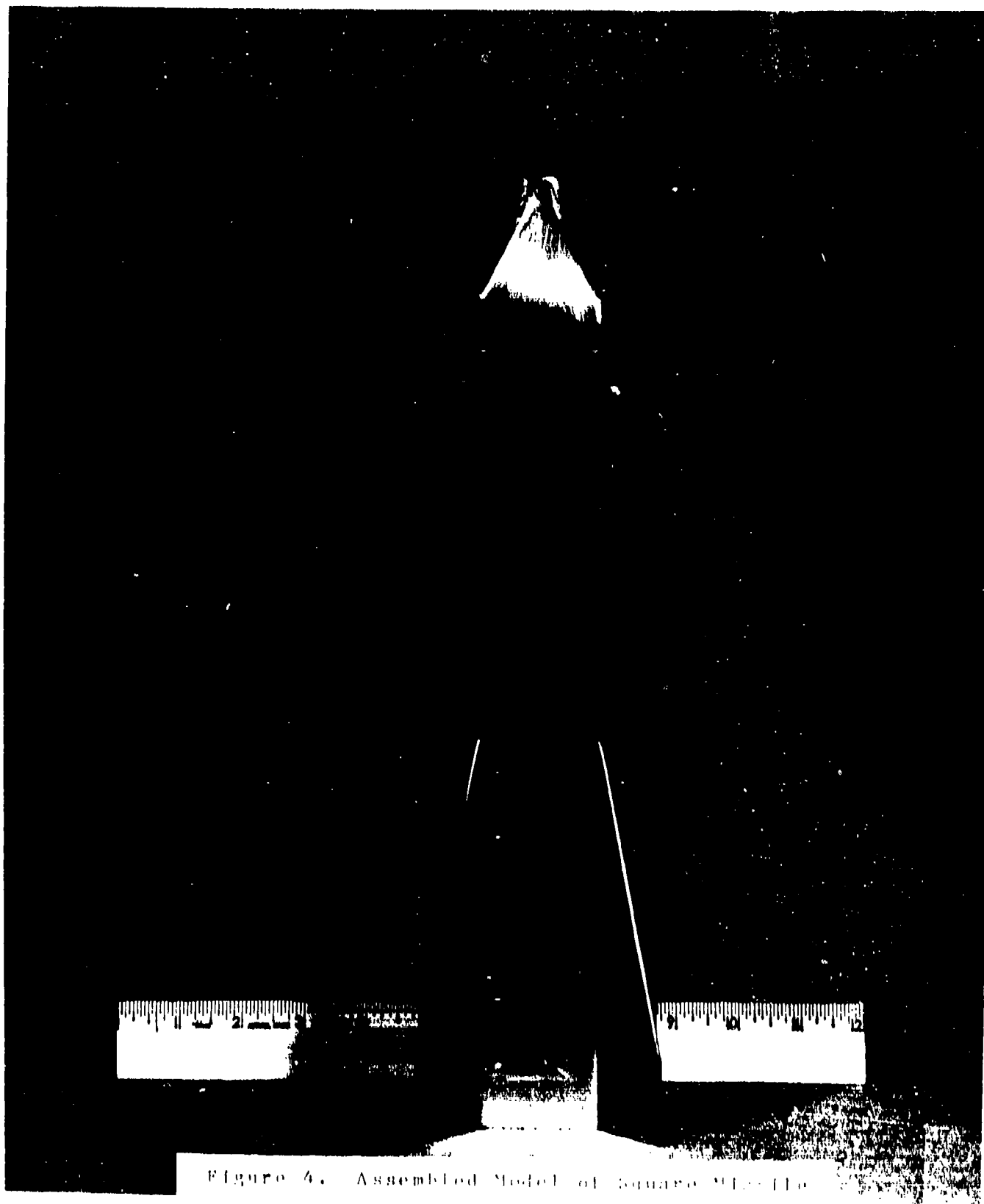


Figure 4. Assembled Model of Square Missile



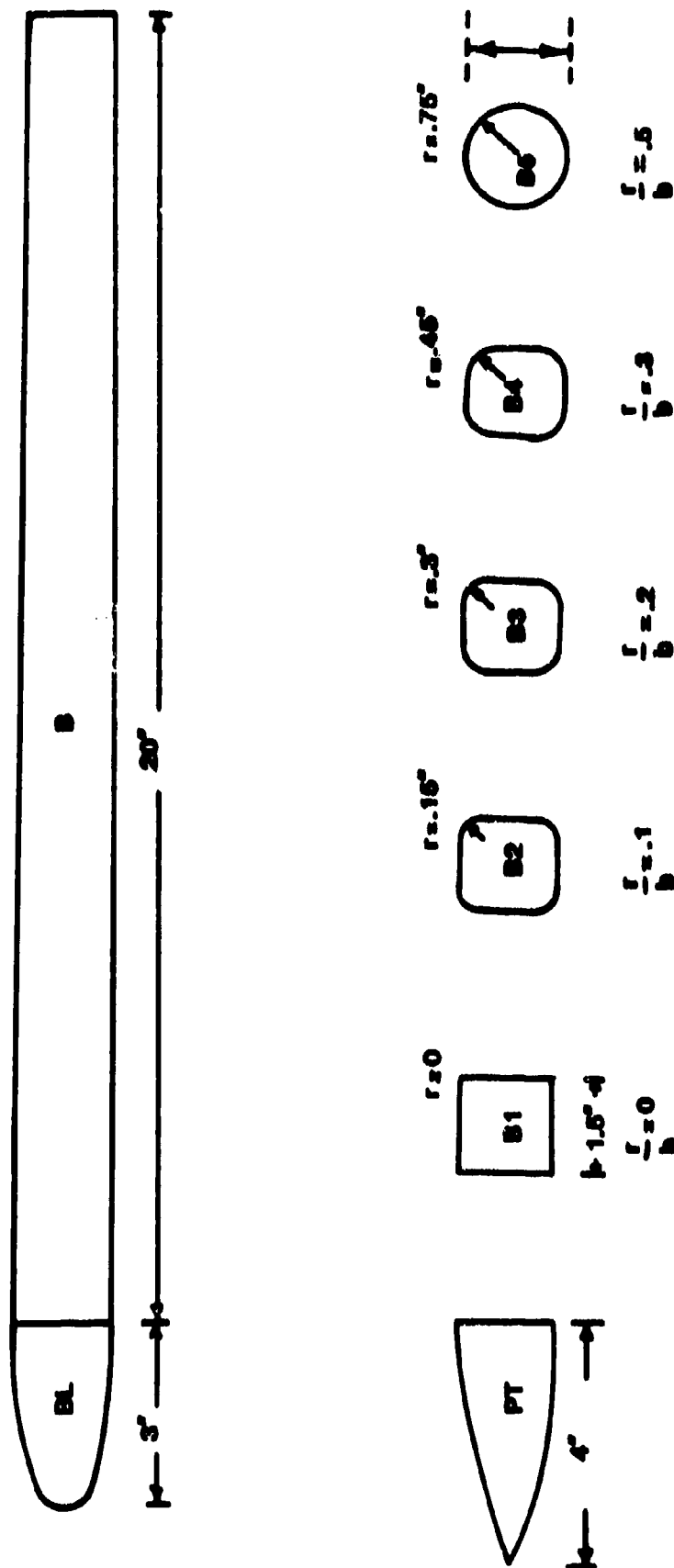


Figure 5. Missile of Fitness Ratio 16 Components

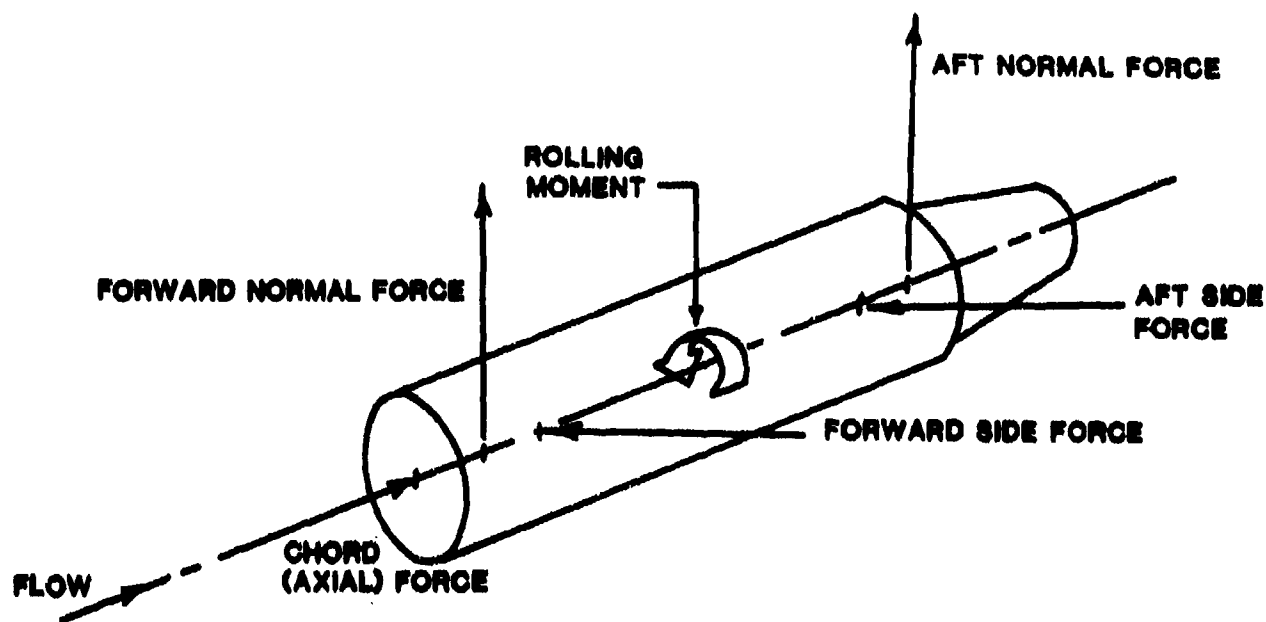


Figure 6a. Balance Loads

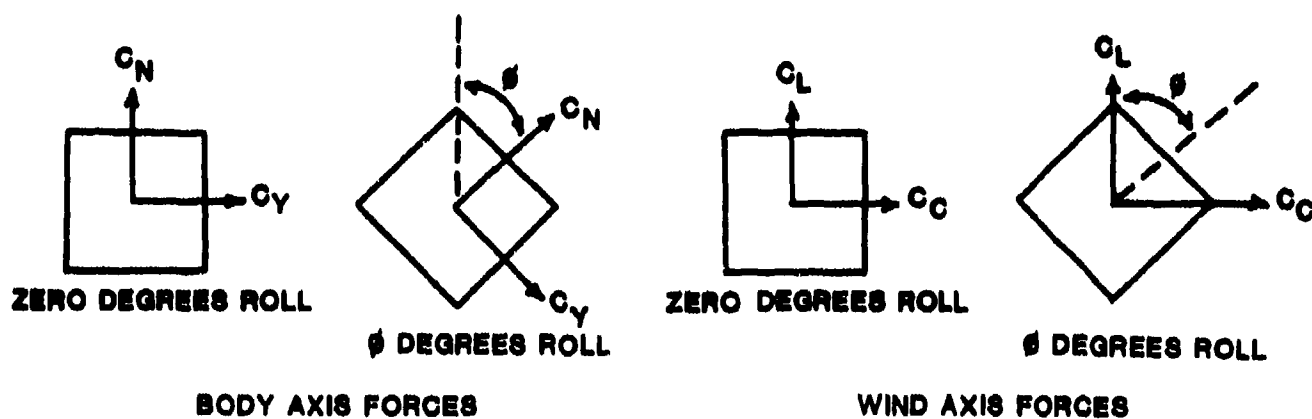


Figure 6b. Body and Wind Axis Systems (Looking at Aft Side of the Model). Direction of Airflow Is Out of Plane of Paper

Figure 6. Direction of Positive Forces

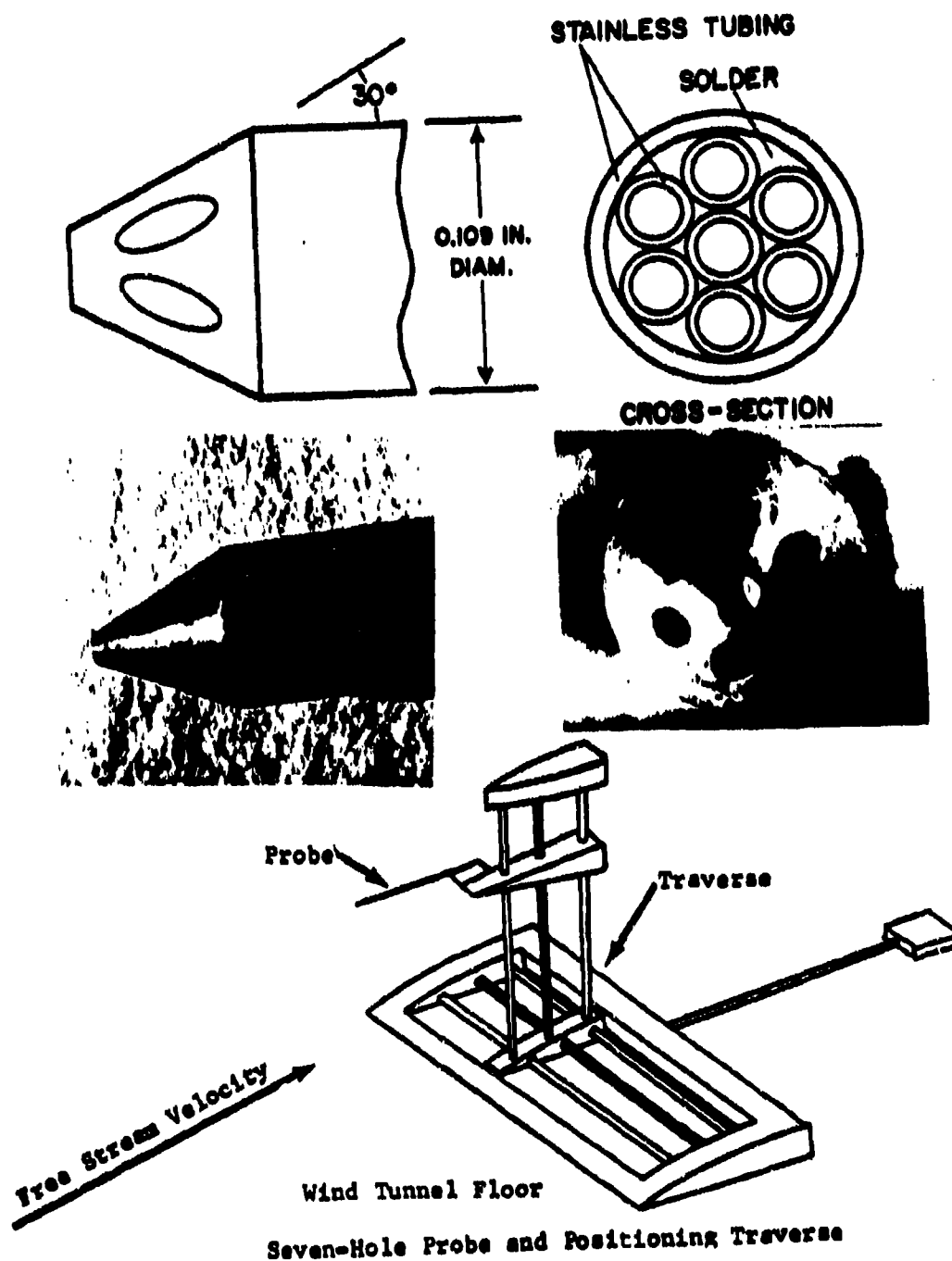


Figure 7. Seven-Hole Probe and Positioning System

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## Appendix A

### FORCE AND MOMENT COMPARISONS OF VARIOUS MISSILE CONFIGURATIONS

Force and moment tests were conducted only on the missiles of fineness ratio equal to 8. Each model configuration was mounted on the sting at the pitch center of the pitch rotation system which placed the force and moment balance center at the tunnel test section centerline. Six components of force and moment data were taken in two degree increments from 0 to 30 degrees pitch angle at roll orientations of 0, 11.25, 22.5, 33.75, and 45 degrees. The angle between the longitudinal axis of the sting and the freestream velocity was defined as the pitch angle and for a 0 degree roll orientation the pitch angle and angle of attack were the same. At the other roll orientations the pitch angle equated to a combination of angle of attack and sideslip. The freestream velocity was approximately 360 fps ( $M = .31$ ) and the Reynolds number was approximately  $2.5 \times 10^5$  for all tests. Forces and moments were recorded in either the body or wind axes systems. All results were non-dimensionalized using the cross-sectional area (0.0218 square feet) of the circular body (IV) and a length of the body cross-section width (2 inches for bodies I-IV).

Force and Moment coefficients are graphically plotted in Figures A-01 through A-30. Figures A-01 through A-18 show body axis data

while Figures A-19 through A-30 show wind axis data. All coefficients are plotted versus pitch angle from zero to 30 degrees. Besides showing the effects of pitch angle variation, the graphs also illustrate the effects of changes in body corner radius, nose variation and fin variation. Also shown above each graph is a data scheme that illustrates the missile configuration tested. Each configuration was labeled according to the component nomenclature shown in Figure 2. For instance, the square body tested at 22.5 roll and with the 4-inch length fin and blunt nose configuration is noted as I/22.5/F1/BL. Table A-1 illustrates the nomenclature for the force and moment coefficients. Table A-2 summarizes the 30 figures in the appendix.

TABLE A-1

FORCE/MOMENT COEFFICIENTS

| <u>Wind Axis</u>                  | <u>Body Axis</u>                   |
|-----------------------------------|------------------------------------|
| CL - Lift Coefficient             | CN - Normal Force Coefficient      |
| CD - Drag Coefficient             | CA - Axial Force Coefficient       |
| CC - Cross-Force Coefficient      | CY - Side-Force Coefficient        |
| CMW - Pitching Moment Coefficient | CM - Pitching Moment Coefficient   |
| CLW - Rolling Moment Coefficient  | ROLCO - Rolling Moment Coefficient |
| CNW - Yawing Moment Coefficient   | YMCO - Yawing Moment Coefficient   |



TABLE A- 2  
SUMMARY OF FORCE AND MOMENT GRAPHS

BODY AXIS SYSTEM DATA

| <u>Appendix<br/>Figure</u> | <u>Missile<br/>Configuration</u>     | <u>Parameter<br/>Varied</u> |
|----------------------------|--------------------------------------|-----------------------------|
| A-1                        | 0° Roll, No Fins, Blunt Nose         | Corner Radius (Bodies I-IV) |
| A-2                        | 22° Roll, No Fins, Blunt Nose        | Corner Radius (Bodies I-IV) |
| A-3                        | 45° Roll, No Fins, Blunt Nose        | Corner Radius (Bodies I-IV) |
| A-4                        | 0° Roll, Fin 1, Blunt Nose           | Corner Radius (Bodies I-IV) |
| A-5                        | 22° Roll, Fin 1, Blunt Nose          | Corner Radius (Bodies I-IV) |
| A-6                        | 45° Roll, Fin 1, Blunt Nose          | Corner Radius (Bodies I-IV) |
| A-7                        | Missile III, 0° Roll, No Fins/Fin 1  | Noses (BL & PT Noses)       |
| A-8                        | Missile III, 22° Roll, No Fins/Fin 1 | Noses (BL & PT Noses)       |
| A-9                        | Missile III, 45° Roll, No Fins/Fin 1 | Noses (BL & PT Noses)       |
| A-10                       | Missile III, 0° Roll, F1 & F3        | Noses (BL & PT Noses)       |
| A-11                       | Missile III, 22° Roll, F1 & F3       | Noses (BL & PT Noses)       |
| A-12                       | Missile III, 45° Roll, F1 & F3       | Noses (BL & PT Noses)       |
| A-13                       | Missile III, 0° Roll, Blunt Nose     | Fins (NF, F1, F2, F3)       |
| A-14                       | Missile III, 22° Roll, Blunt Nose    | Fins (NF, F1, F2, F3)       |
| A-15                       | Missile III, 45° Roll, Blunt Nose    | Fins (NF, F1, F2, F3)       |
| A-16                       | Missile III, 0° Roll, Pointed Nose   | Fins (NF, F1, F2, F3)       |
| A-17                       | Missile III, 22° Roll, Pointed Nose  | Fins (NF, F1, F2, F3)       |
| A-18                       | Missile III, 45° Roll, Pointed Nose  | Fins (NF, F1, F2, F3)       |

Table A-2 Summary of Force and Moment Graphs (cont'd)

WIND AXIS SYSTEM DATA

| <u>Appendix<br/>Figure</u> | <u>Missile<br/>Configuration</u>     | <u>Parameter<br/>Varied</u> |
|----------------------------|--------------------------------------|-----------------------------|
| A-19                       | 11° Roll, No Fins, Blunt Nose        | Corner Radius (Bodies I-IV) |
| A-20                       | 33° Roll, No Fins, Blunt Nose        | Corner Radius (Bodies I-IV) |
| A-21                       | 11° Roll, Fin 1, Blunt Nose          | Corner Radius (Bodies I-IV) |
| A-22                       | 33° Roll, Fin 1, Blunt Nose          | Corner Radius (Bodies I-IV) |
| A-23                       | Missile III, 11° Roll, No Fins/Fin 1 | Noses (BL & PT Noses)       |
| A-24                       | Missile III, 33° Roll, No Fins/Fin 1 | Noses (BL & PT Noses)       |
| A-25                       | Missile III, 11° Roll, F1 & F3       | Noses (BL & PT Noses)       |
| A-26                       | Missile III, 33° Roll, F1 & F3       | Noses (BL & PT Noses)       |
| A-27                       | Missile III, 11° Roll, Blunt Nose    | Fins (NF, F1, F2, F3)       |
| A-28                       | Missile III, 33° Roll, Blunt Nose    | Fins (NF, F1, F2, F3)       |
| A-29                       | Missile III, 11° Roll, Pointed Nose  | Fins (NF, F1, F2, F3)       |
| A-30                       | Missile III, 33° Roll, Pointed Nose  | Fins (NF, F1, F2, F3)       |

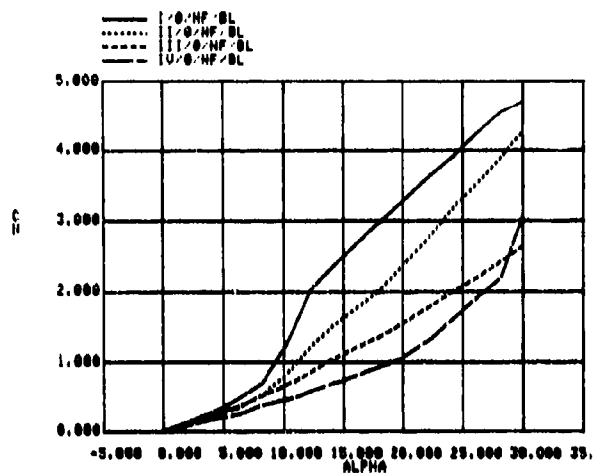


FIGURE A-1.1 BODY CORNER RADIUS EFFECTS

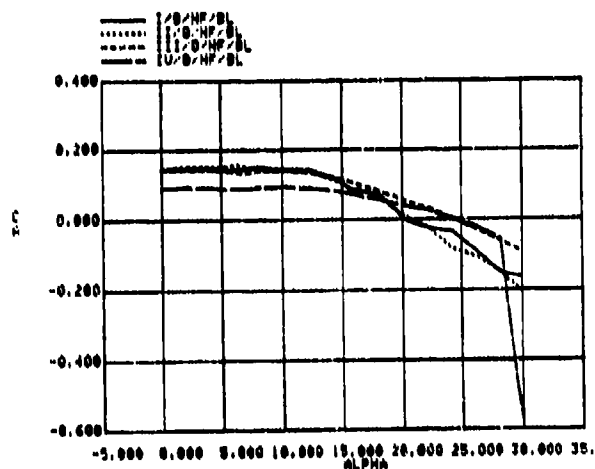


FIGURE A-1.2 BODY CORNER RADIUS EFFECTS

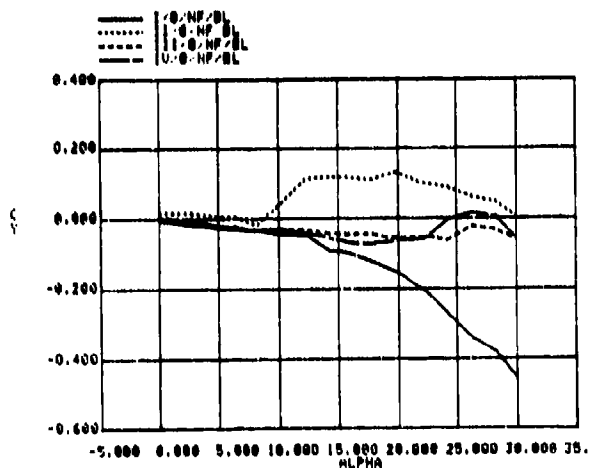


FIGURE A-1.3 BODY CORNER RADIUS EFFECTS

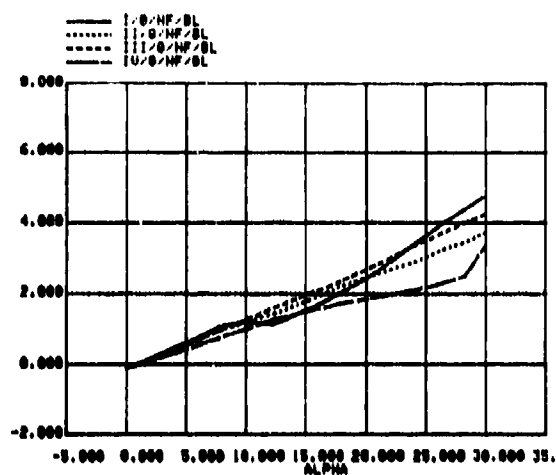


FIGURE A-1.4 BODY CORNER RADIUS EFFECTS

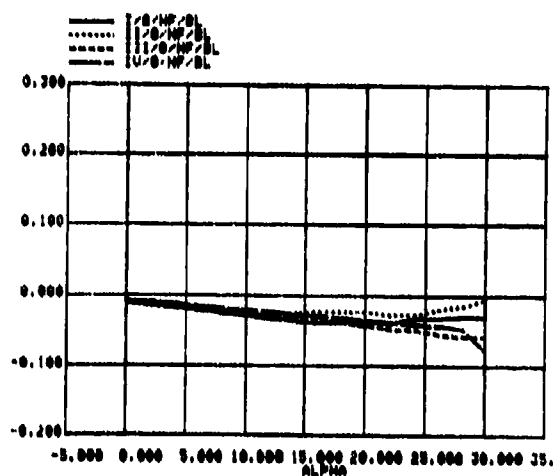


FIGURE A-1.5 BODY CORNER RADIUS EFFECTS

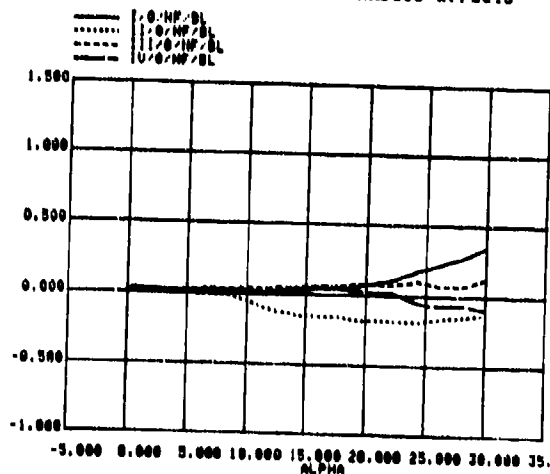


FIGURE A-1.6 BODY CORNER RADIUS EFFECTS

FIGURE A-1. BODY AXIS FORCE & MOMENT BODY EFFECTS, 0 ROLL ANGLE.  
NO FINS, BLUNT NOSE.

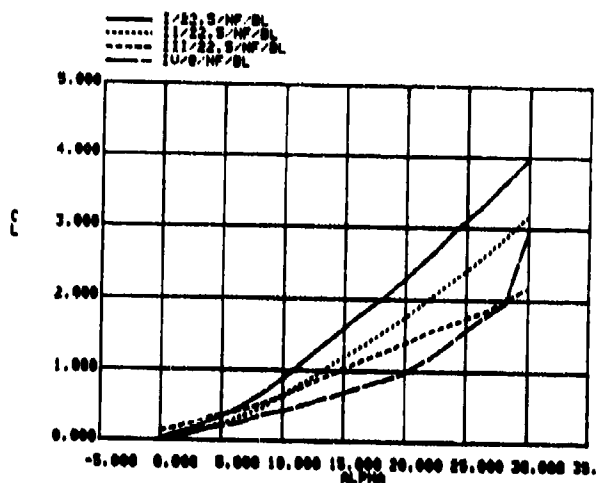


FIGURE A-2.1 BODY CORNER RADIUS EFFECTS

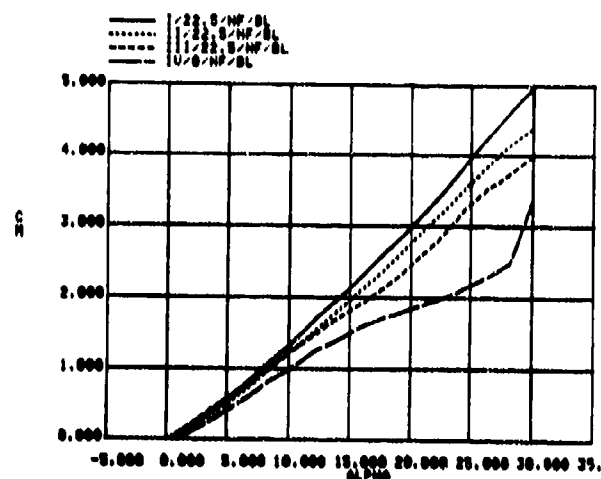


FIGURE A-2.4 BODY CORNER RADIUS EFFECTS

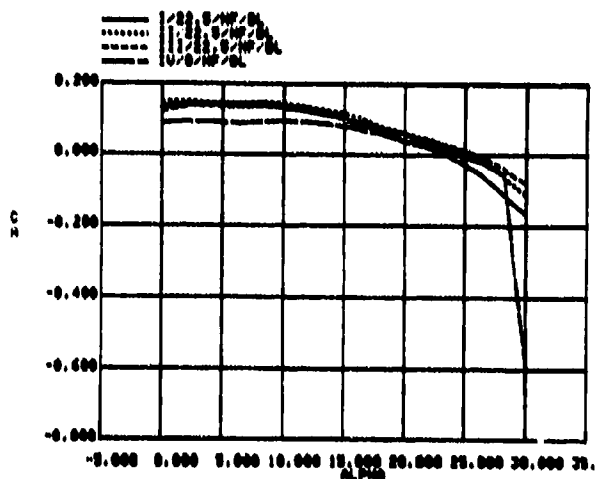


FIGURE A-2.2 BODY CORNER RADIUS EFFECTS

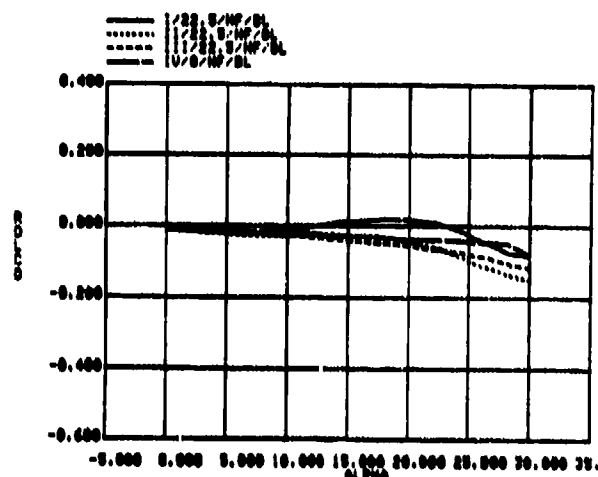


FIGURE A-2.3 BODY CORNER RADIUS EFFECTS

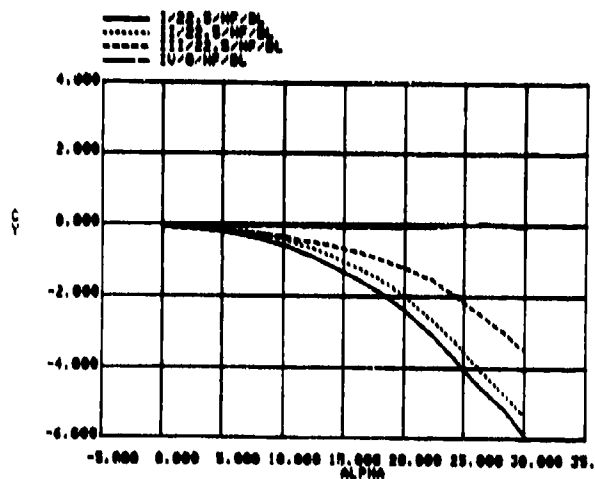


FIGURE A-2.5 BODY CORNER RADIUS EFFECTS

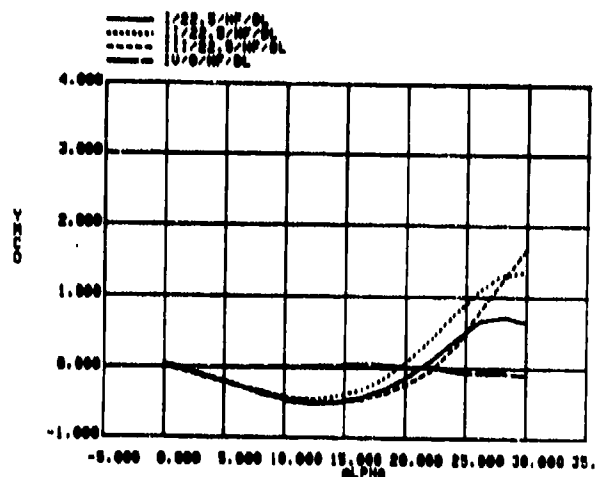


FIGURE A-2.6 BODY CORNER RADIUS EFFECTS

FIGURE A-2. BODY AXIS FORCE & MOMENT BODY EFFECTS, 22 ROLL ANGLE.  
NO FINS, BLUNT NOSE.

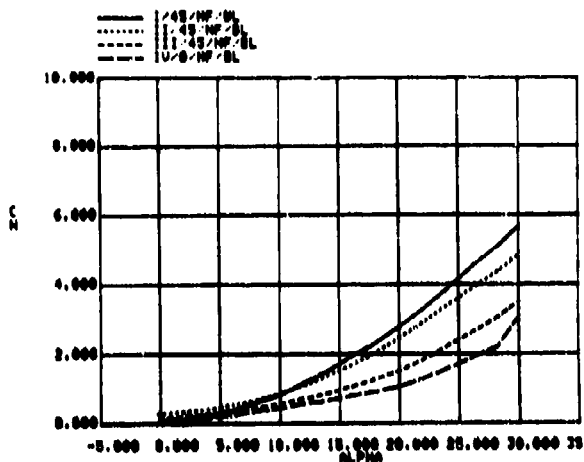


FIGURE A-3.1 BODY CORNER RADIUS EFFECTS

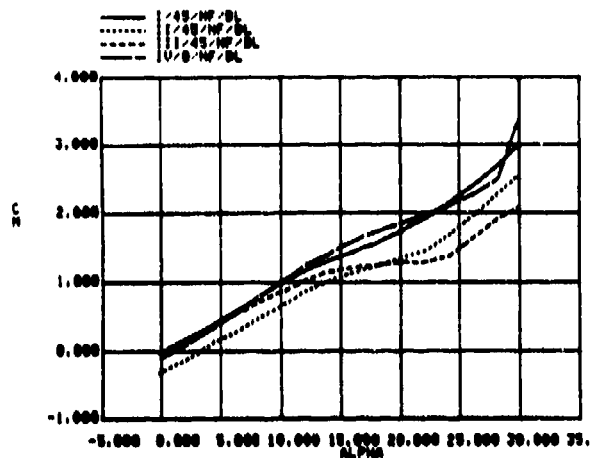


FIGURE A-3.4 BODY CORNER RADIUS EFFECTS

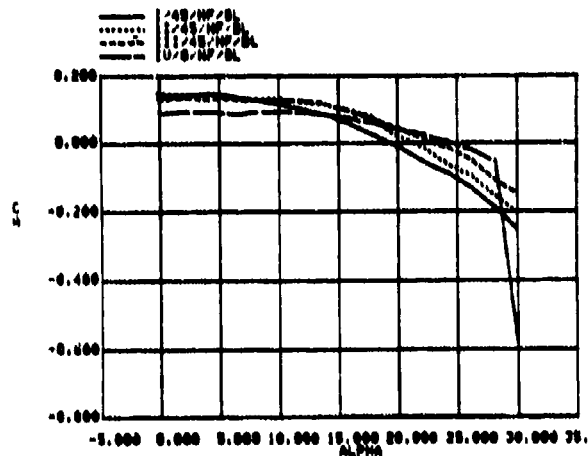


FIGURE A-3.2 BODY CORNER RADIUS EFFECTS

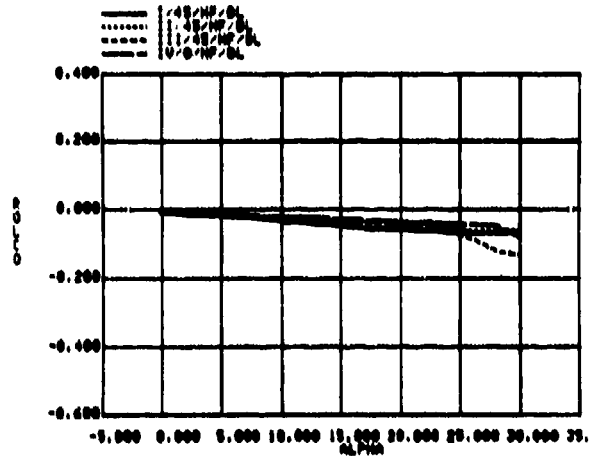


FIGURE A-3.5 BODY CORNER RADIUS EFFECTS

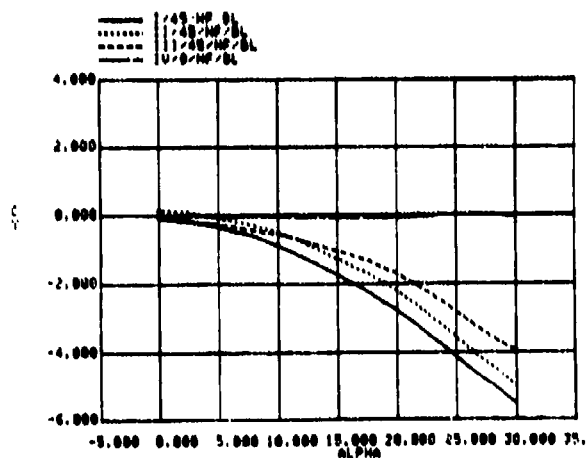


FIGURE A-3.3 BODY CORNER RADIUS EFFECTS

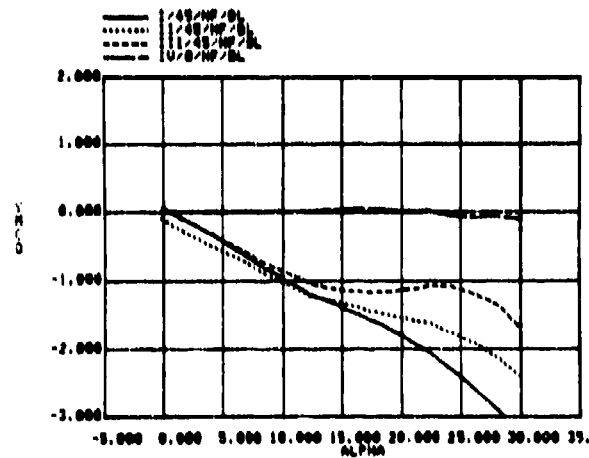


FIGURE A-3.6 BODY CORNER RADIUS EFFECTS

FIGURE A-3. BODY AXIS FORCE & MOMENT BODY EFFECTS, 45 ROLL ANGLE.  
NO FINS, BLUNT NOSE.

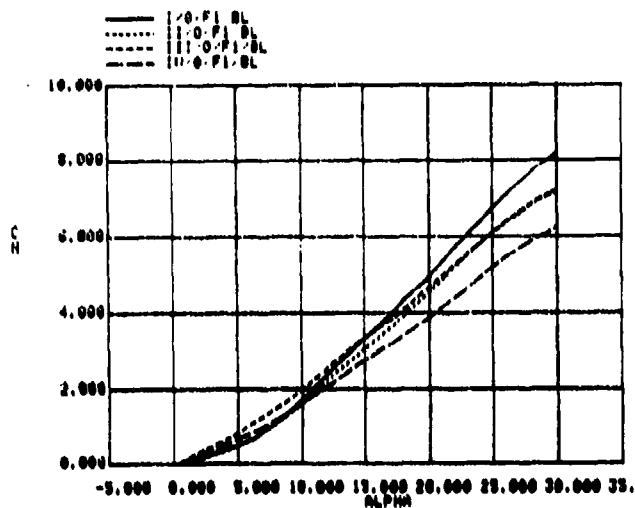


FIGURE A-4.1 BODY CORNER RADIUS EFFECTS

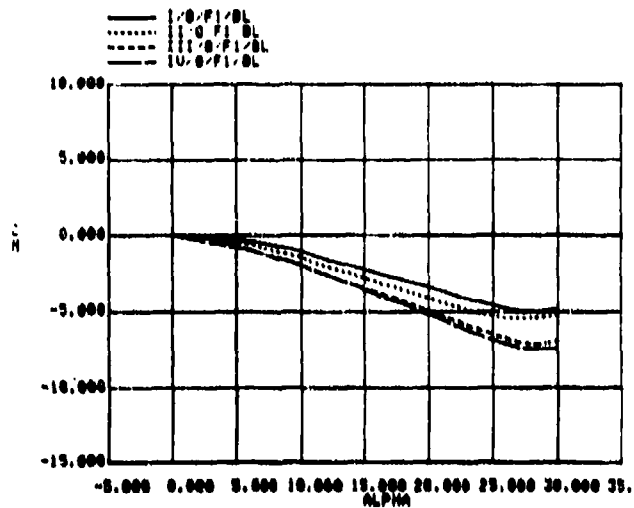


FIGURE A-4.4 BODY CORNER RADIUS EFFECTS

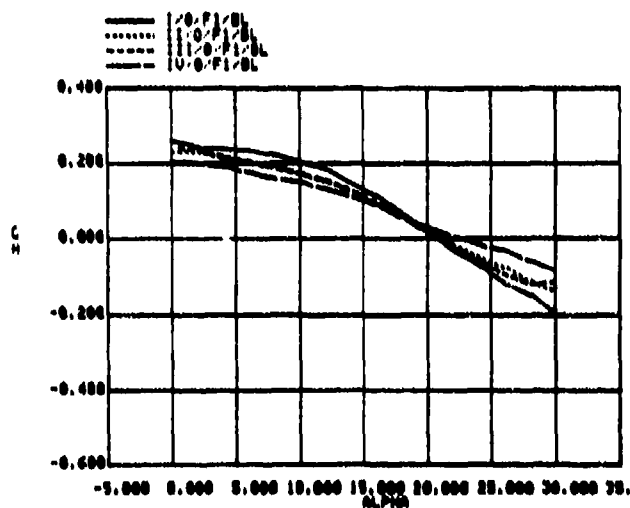


FIGURE A-4.2 BODY CORNER RADIUS EFFECTS

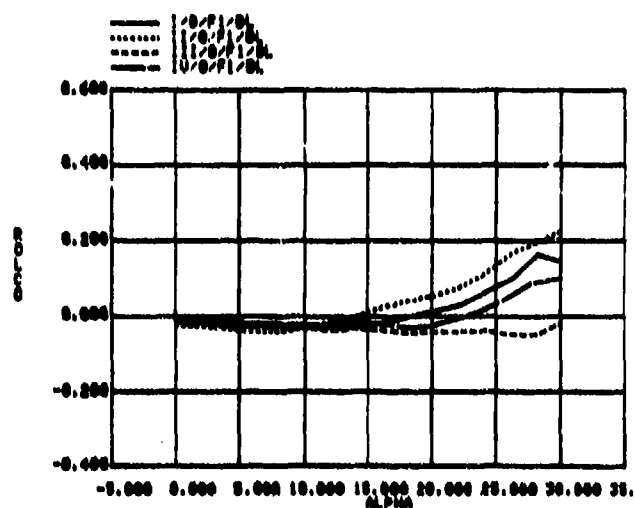


FIGURE A-4.5 BODY CORNER RADIUS EFFECTS

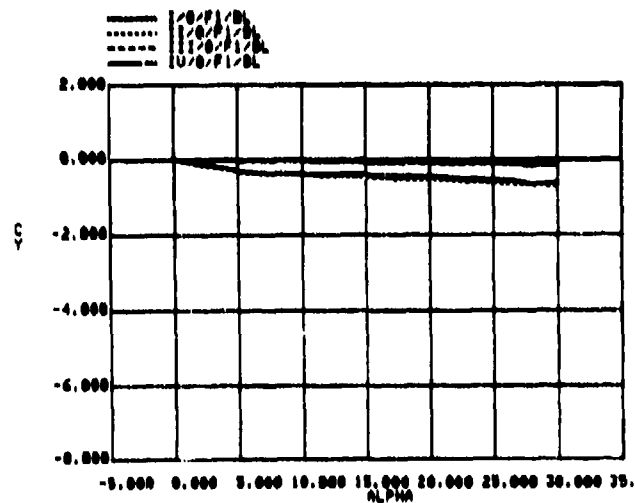


FIGURE A-4.3 BODY CORNER RADIUS EFFECTS

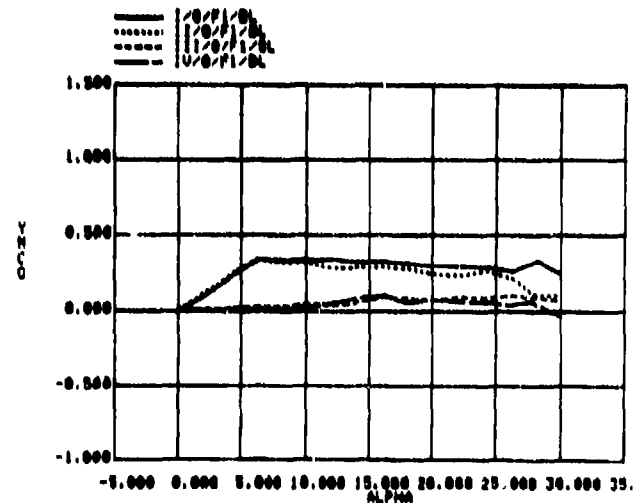


FIGURE A-4.6 BODY CORNER RADIUS EFFECTS

FIGURE A-4. BODY AXIS FORCE & MOMENT BODY EFFECTS, 0 ROLL ANGLE.  
FIN 1, BLUNT NOSE.

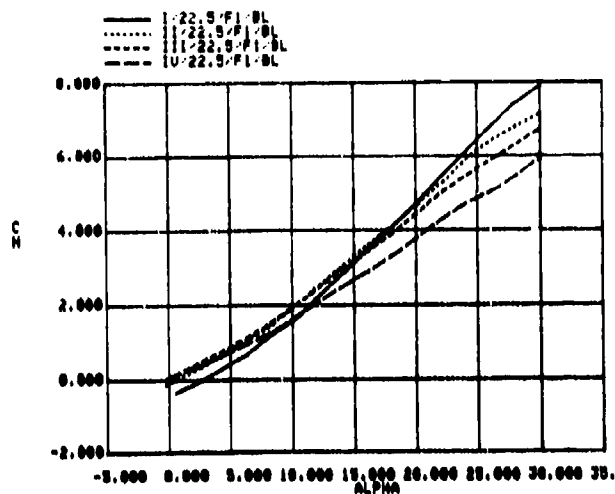


FIGURE A-5.1 BODY CORNER RADIUS EFFECTS

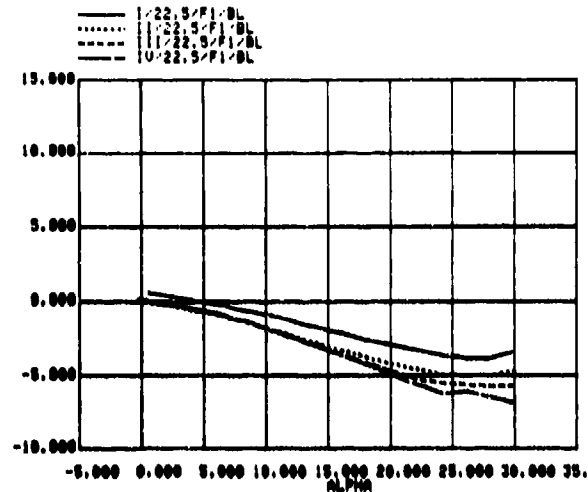


FIGURE A-5.4 BODY CORNER RADIUS EFFECTS

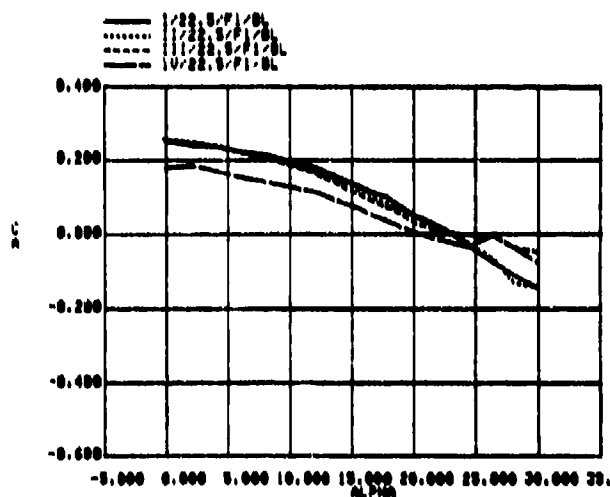


FIGURE A-5.2 BODY CORNER RADIUS EFFECTS

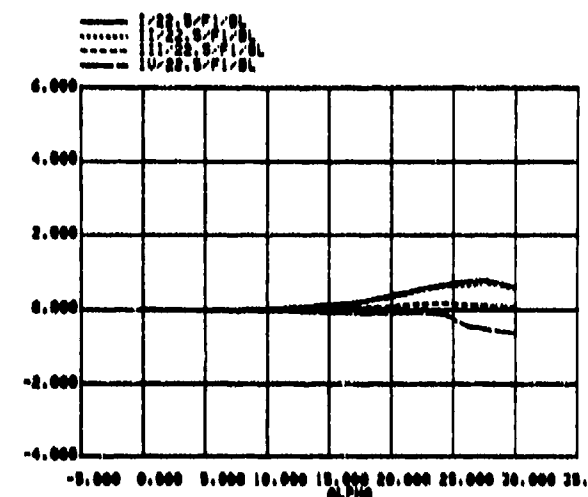


FIGURE A-5.5 BODY CORNER RADIUS EFFECTS

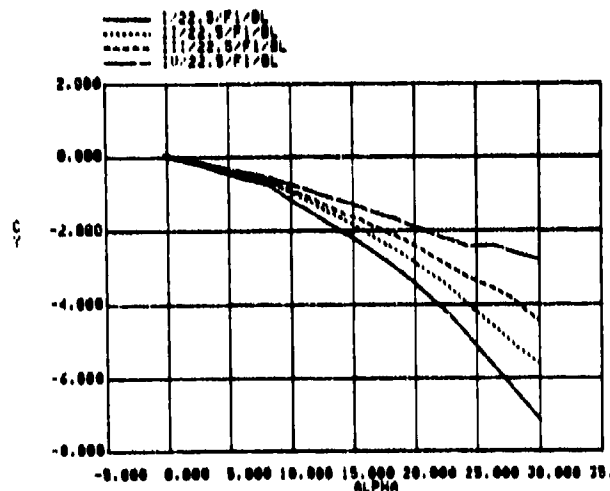


FIGURE A-5.3 BODY CORNER RADIUS EFFECTS

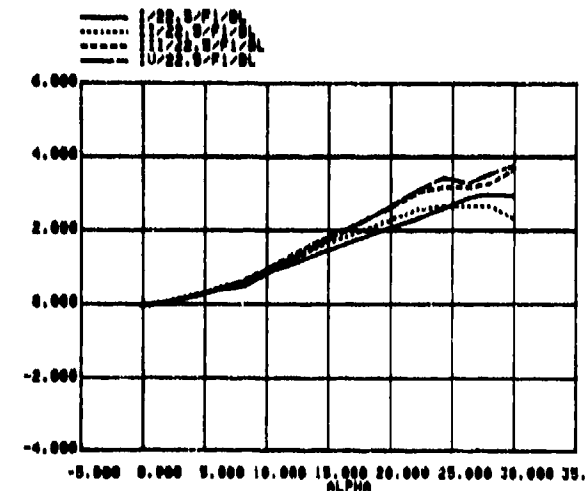


FIGURE A-5.6 BODY CORNER RADIUS EFFECTS

FIGURE A-5. BODY AXIS FORCE & MOMENT BODY EFFECTS, 22 ROLL ANGLE.  
FIN 1, BLUNT NOSE.

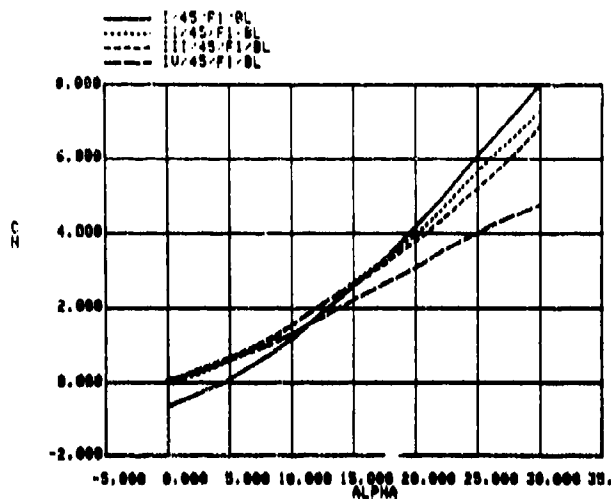


FIGURE A-6.1 BODY CORNER RADIUS EFFECTS

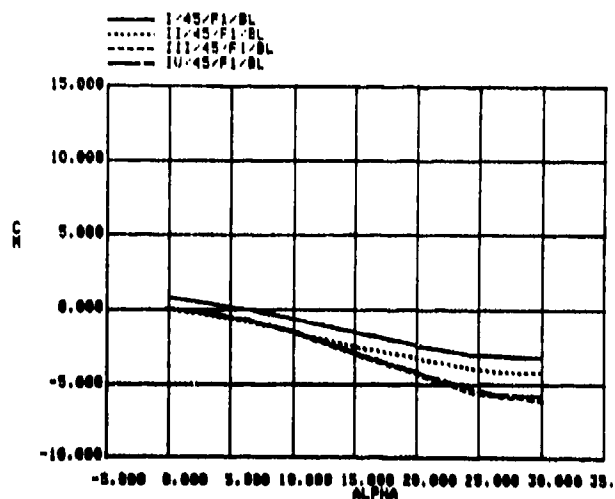


FIGURE A-6.4 BODY CORNER RADIUS EFFECTS

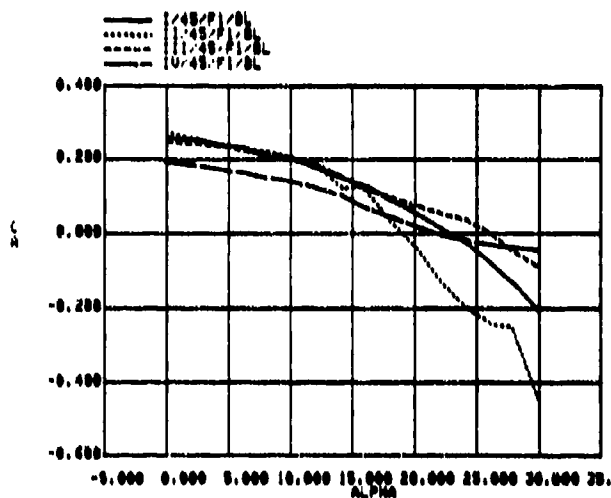


FIGURE A-6.2 BODY CORNER RADIUS EFFECTS

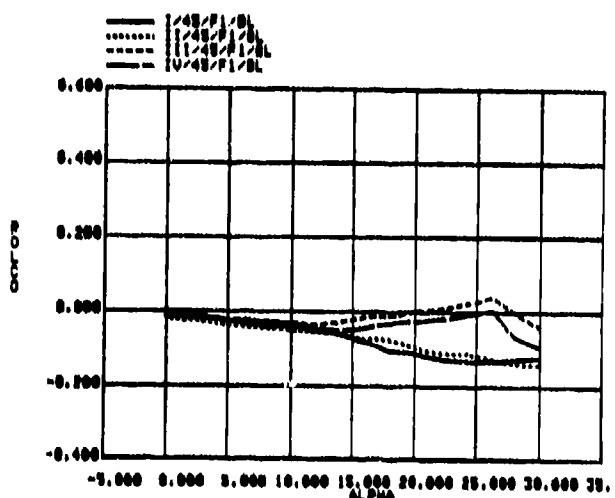


FIGURE A-6.5 BODY CORNER RADIUS EFFECTS

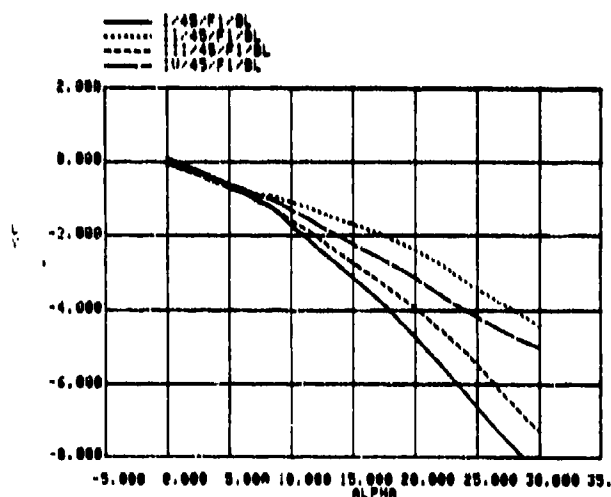


FIGURE A-6.3 BODY CORNER RADIUS EFFECTS

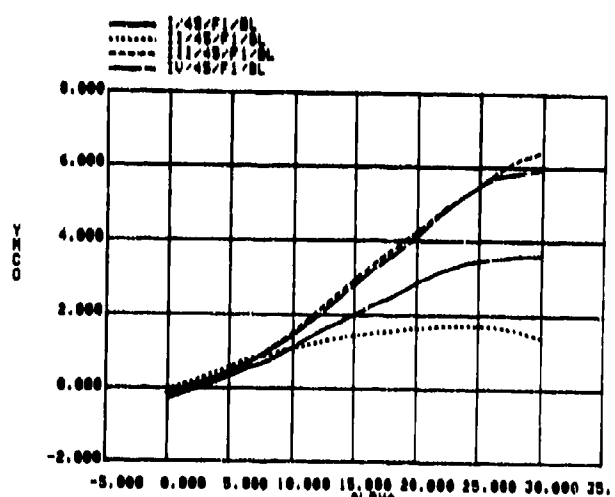


FIGURE A-6.6 BODY CORNER RADIUS EFFECTS

FIGURE A-6. BODY AXIS FORCE & MOMENT BODY EFFECTS, 45 ROLL ANGLE.  
FIN 1, BLUNT NOSE.



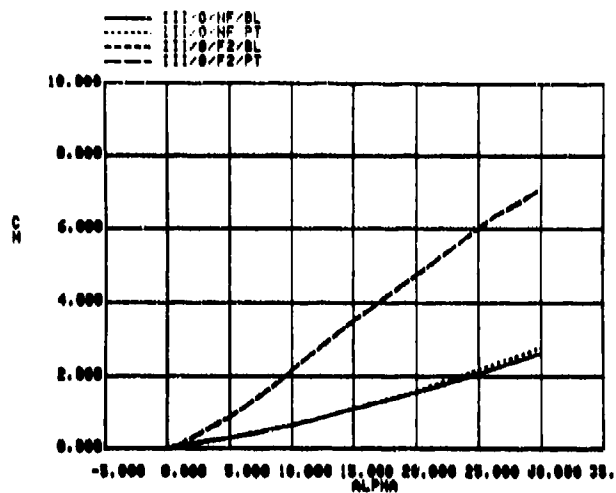


FIGURE A-7.1 NOSE EFFECTS

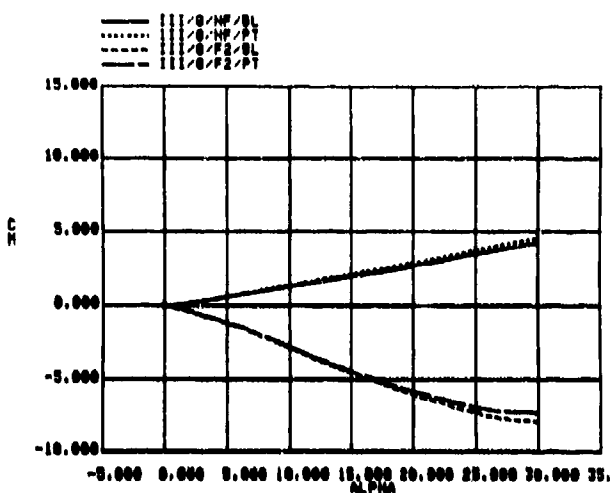


FIGURE A-7.4 NOSE EFFECTS

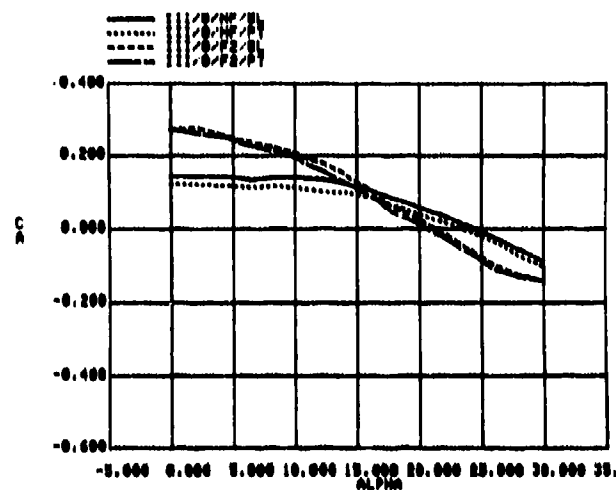


FIGURE A-7.2 NOSE EFFECTS

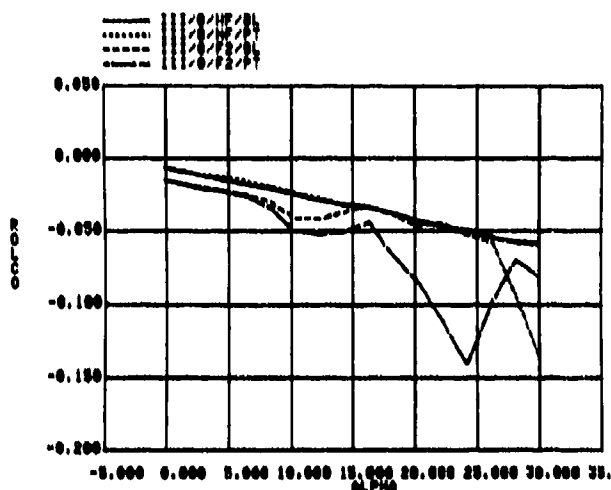


FIGURE A-7.5 NOSE EFFECTS

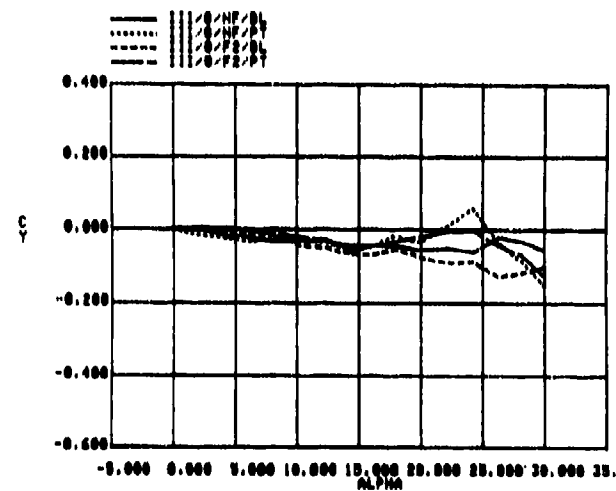


FIGURE A-7.3 NOSE EFFECTS

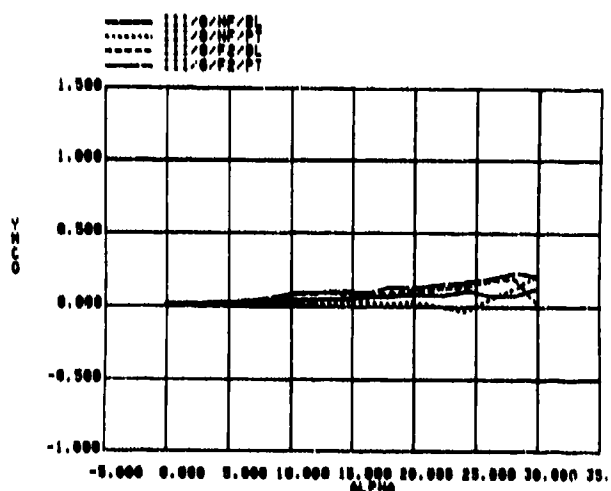


FIGURE A-7.6 NOSE EFFECTS

FIGURE A-7. BODY AXIS FORCE & MOMENT NOSE EFFECTS, MISSILE III.  
ROLL 0, NO FIN/FIN 2, BLUNT/POINTED NOSE.

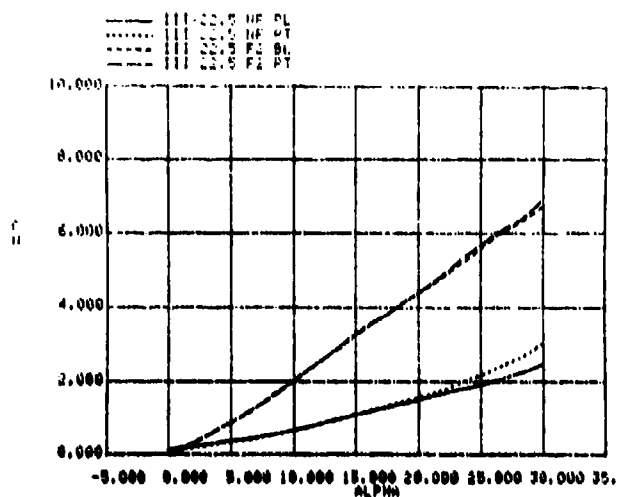


FIGURE A-8.1 NOSE EFFECTS

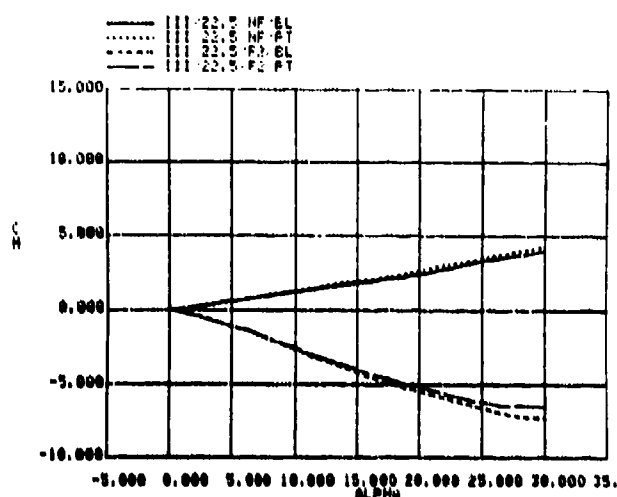


FIGURE A-8.4 NOSE EFFECTS

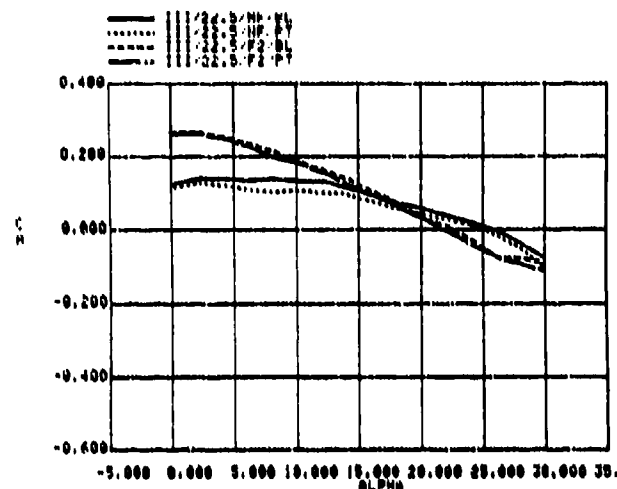


FIGURE A-8.2 NOSE EFFECTS

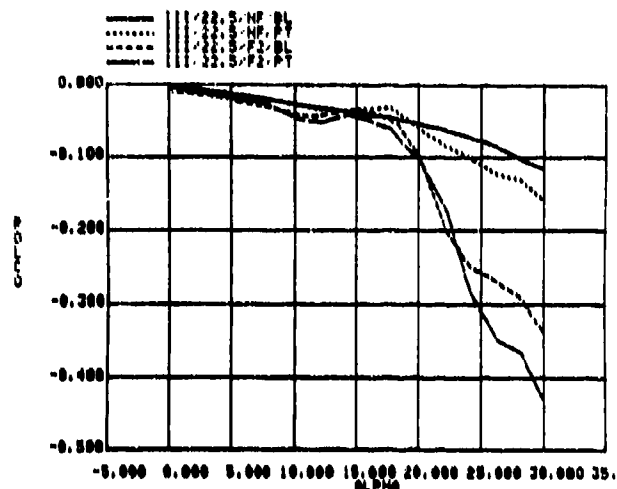


FIGURE A-8.5 NOSE EFFECTS

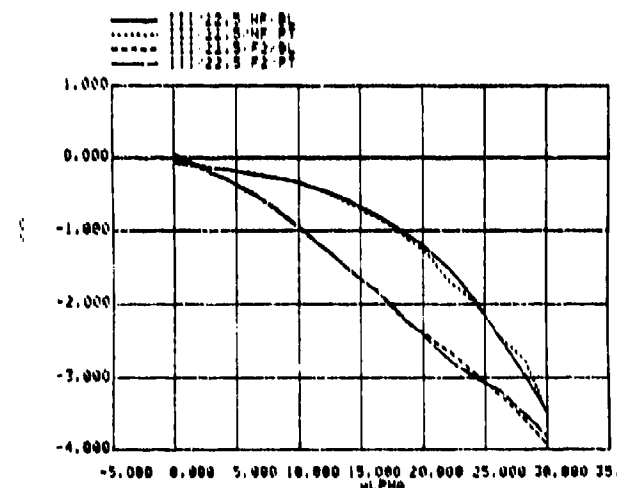


FIGURE A-8.3 NOSE EFFECTS

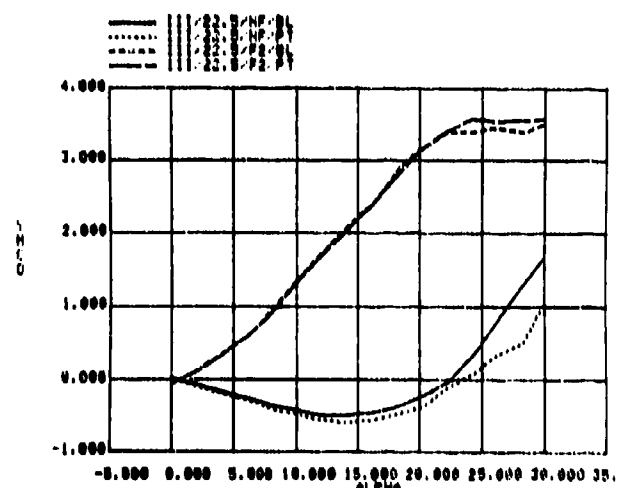


FIGURE A-8.6 NOSE EFFECTS

FIGURE A-8. BODY AXIS FORCE & MOMENT NOSE EFFECTS, MISSILE III.  
ROLL 22, NO FIN/FIN 2, BLUNT/POINTED NOSE.

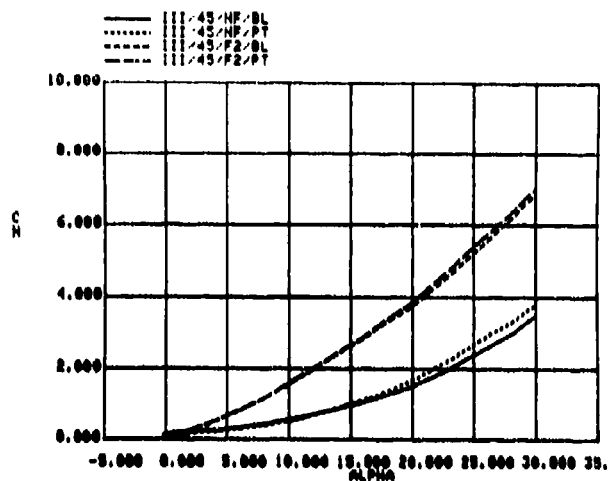


FIGURE A-9.1 NOSE EFFECTS

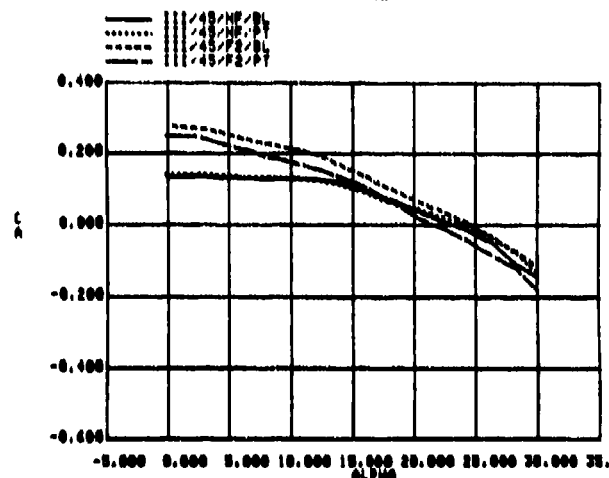


FIGURE A-9.2 NOSE EFFECTS

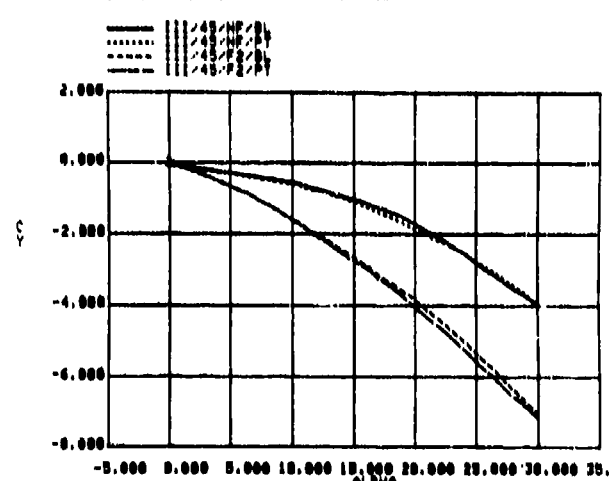


FIGURE A-9.3 NOSE EFFECTS

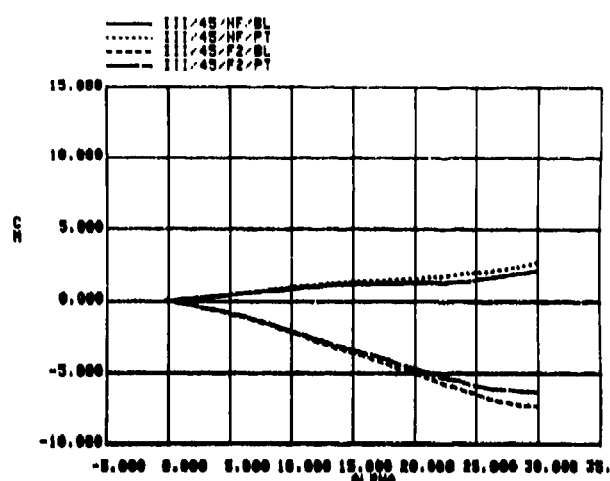


FIGURE A-9.4 NOSE EFFECTS

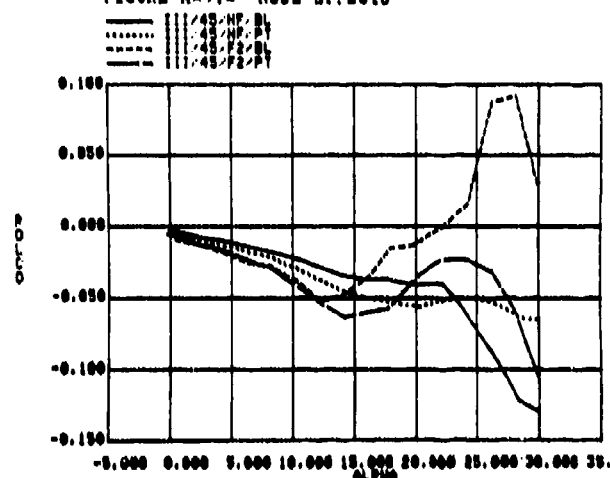


FIGURE A-9.5 NOSE EFFECTS

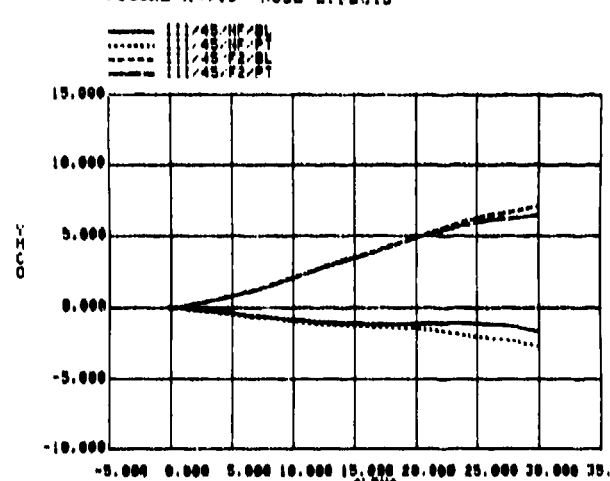


FIGURE A-9.6 NOSE EFFECTS

FIGURE A-9. BODY AXIS FORCE & MOMENT NOSE EFFECTS, MISSILE III.  
ROLL 45, NO FIN/FIN 2, BLUNT/POINTED NOSE.

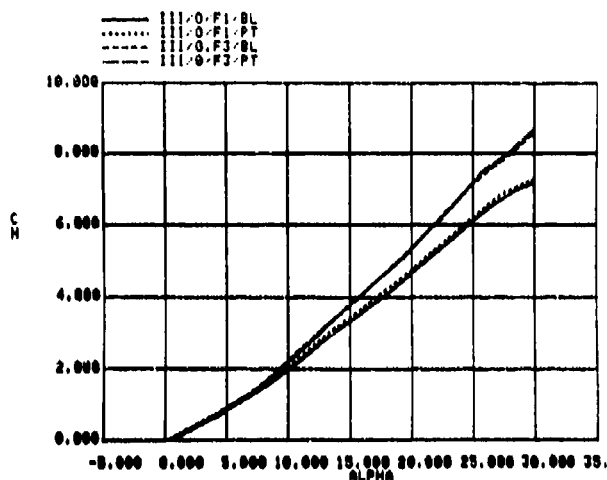


FIGURE A-10.1 NOSE EFFECTS

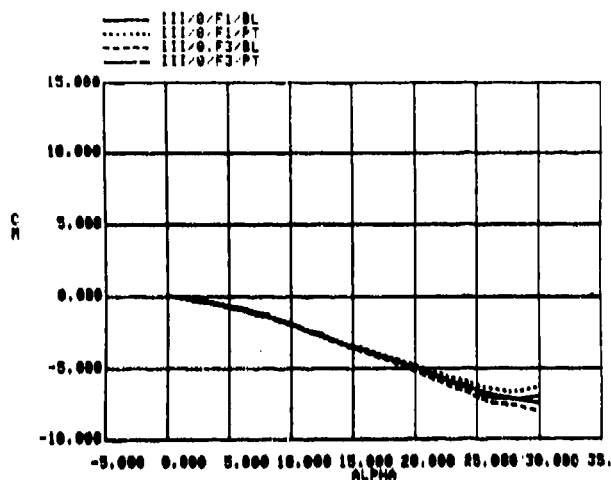


FIGURE A-10.4 NOSE EFFECTS

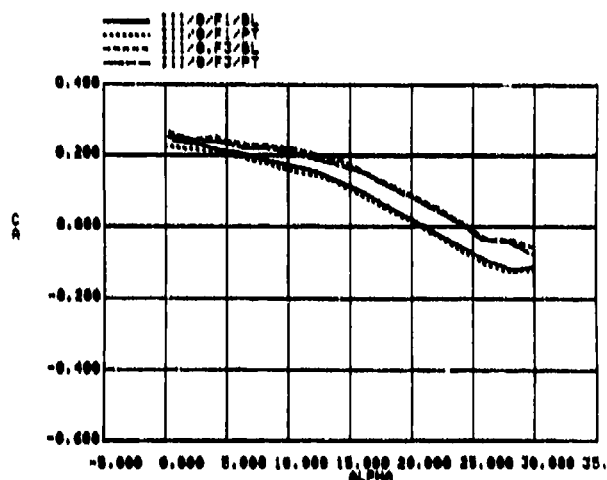


FIGURE A-10.2 NOSE EFFECTS

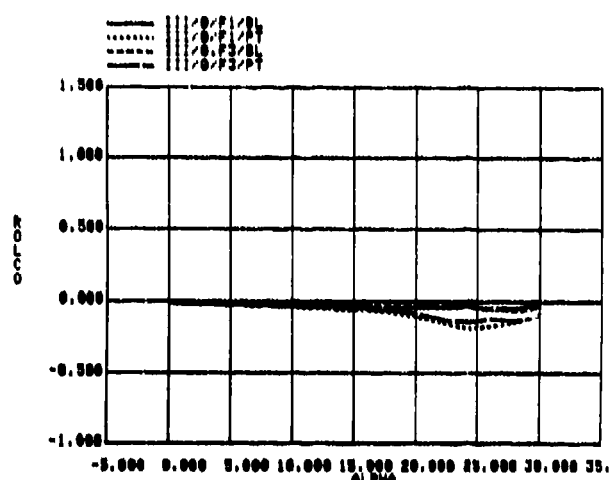


FIGURE A-10.5 NOSE EFFECTS

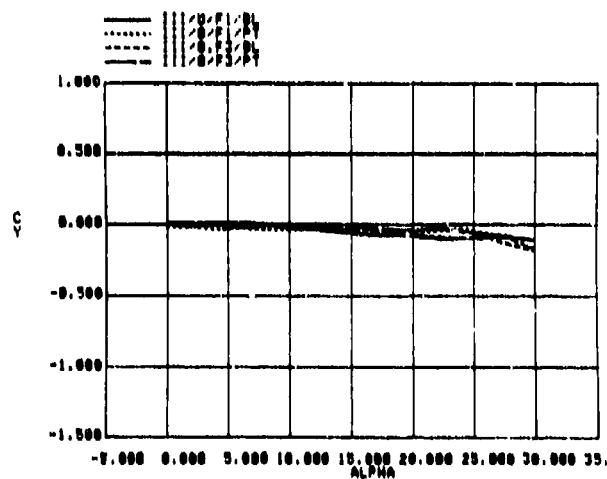


FIGURE A-10.3 NOSE EFFECTS

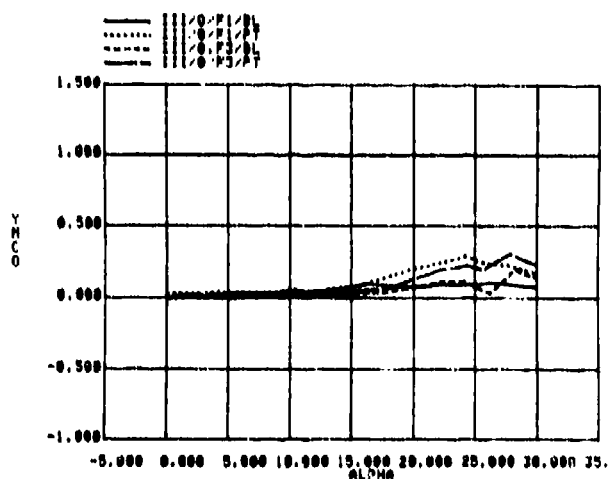


FIGURE A-10.6 NOSE EFFECTS

FIGURE A-10. BODY AXIS FORCE & MOMENT NOSE EFFECTS, MISSILE III.  
ROLL 0, FIN 1/FIN 3, BLUNT/POINTED NOSE.

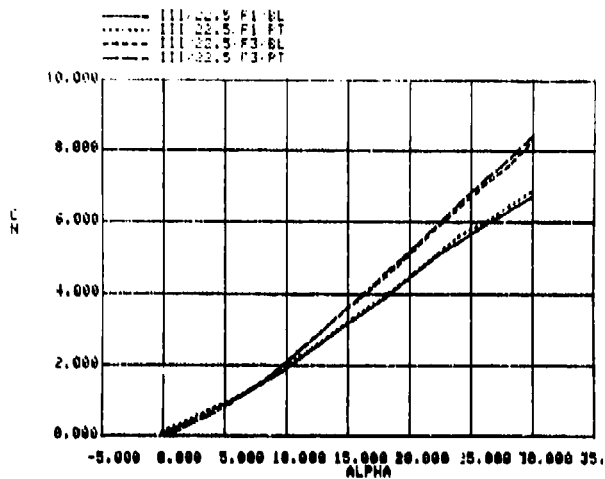


FIGURE A-11.1 NOSE EFFECTS

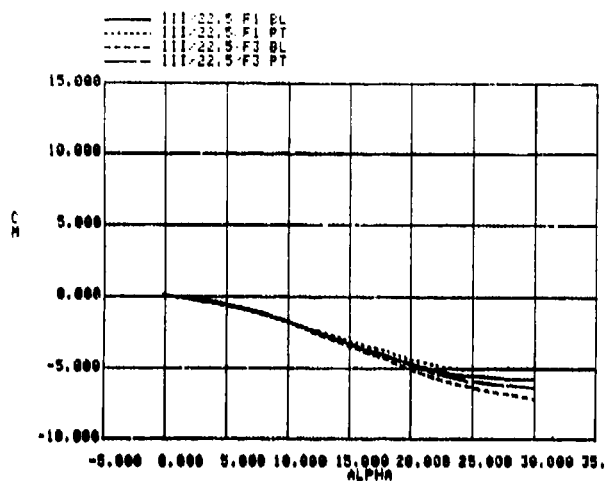


FIGURE A-11.4 NOSE EFFECTS

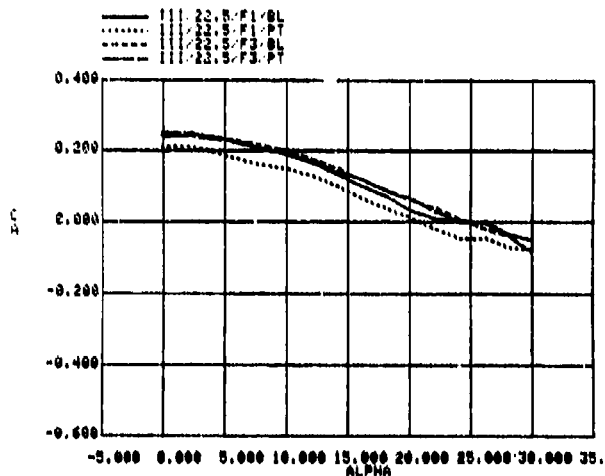


FIGURE A-11.2 NOSE EFFECTS

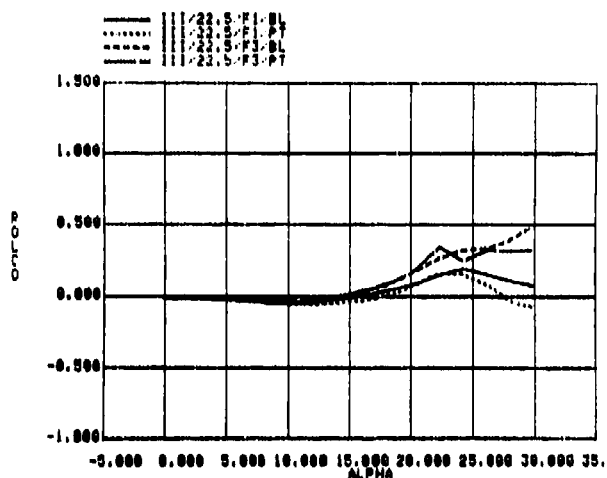


FIGURE A-11.5 NOSE EFFECTS

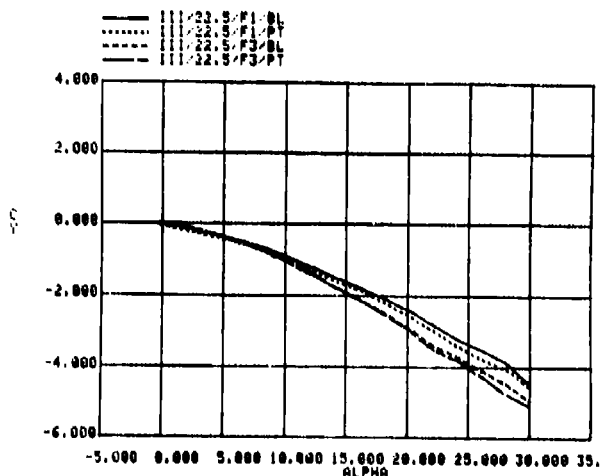


FIGURE A-11.3 NOSE EFFECTS

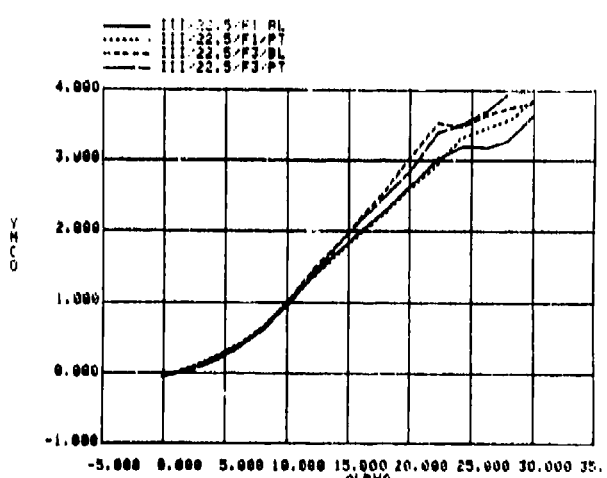


FIGURE A-11.6 NOSE EFFECTS

FIGURE A-11. BODY AXIS FORCE & MOMENT NOSE EFFECTS, MISSILE III.  
ROLL 22, FIN 1/FIN 3, BLUNT/POINTED NOSE.

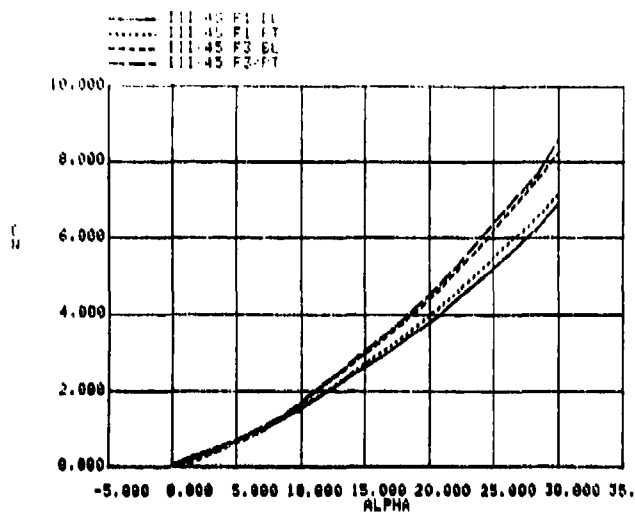


FIGURE A-12.1 NOSE EFFECTS

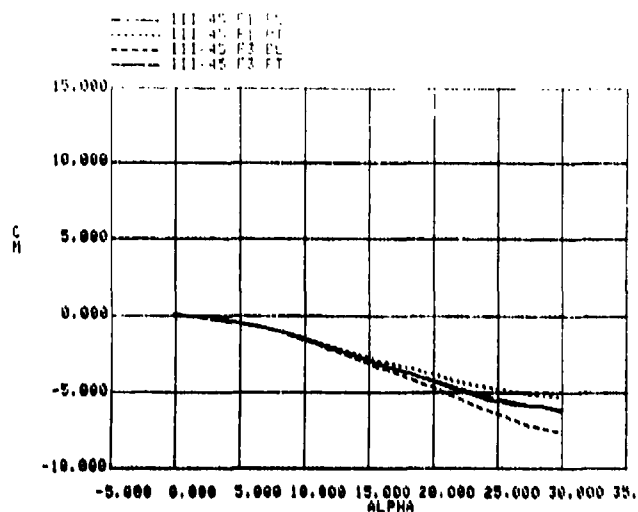


FIGURE A-12.4 NOSE EFFECTS

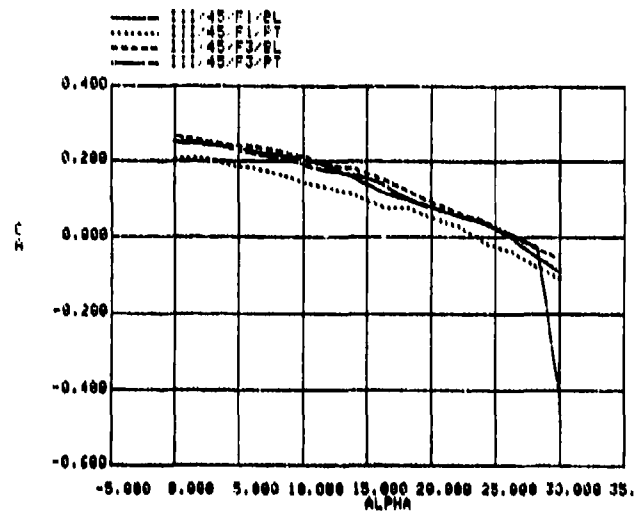


FIGURE A-12.2 NOSE EFFECTS

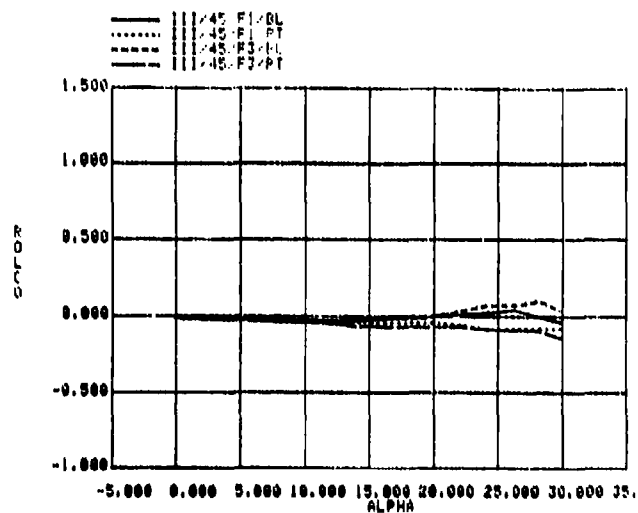


FIGURE A-12.5 NOSE EFFECTS

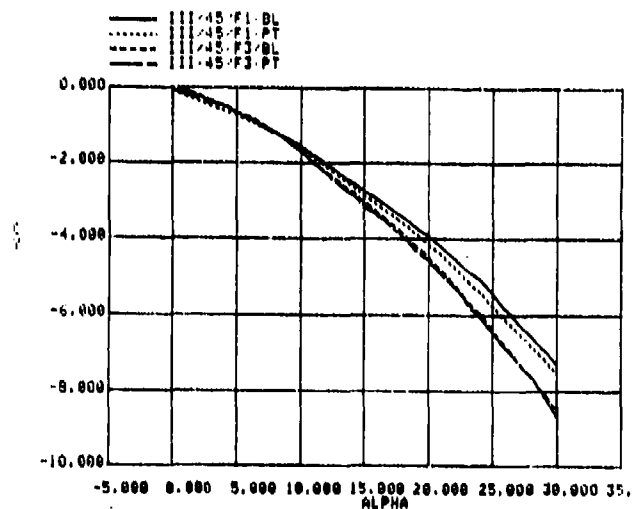


FIGURE A-12.3 NOSE EFFECTS

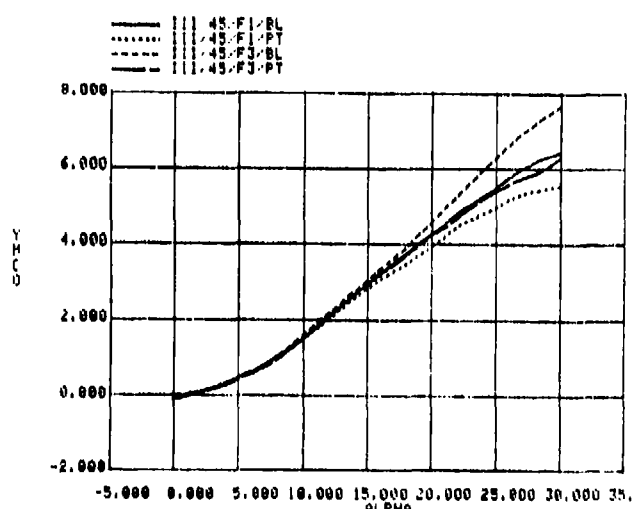


FIGURE A-12.6 NOSE EFFECTS

FIGURE A-12. BODY AXIS FORCE & MOMENT NOSE EFFECTS, MISSILE III.  
ROLL 45, FIN 1/FIN 3, BLUNT/POINTED NOSE.

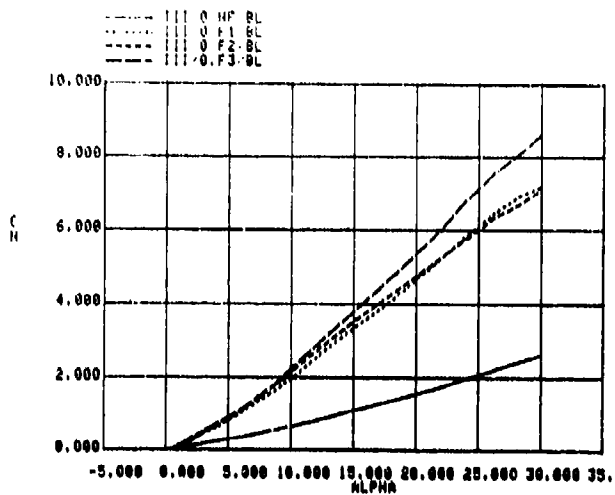


FIGURE A-13.1 FIN EFFECTS

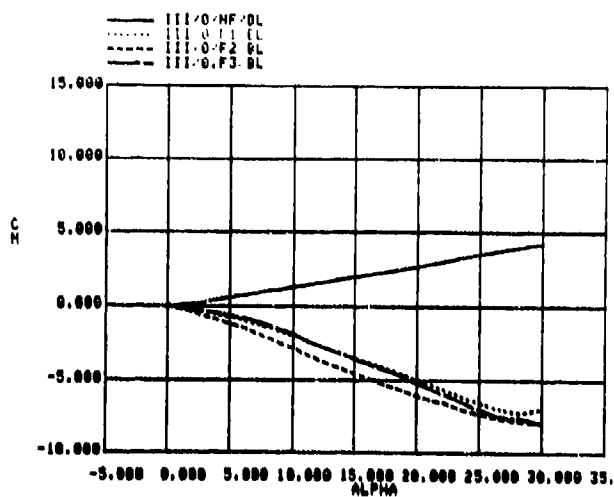


FIGURE A-13.4 FIN EFFECTS

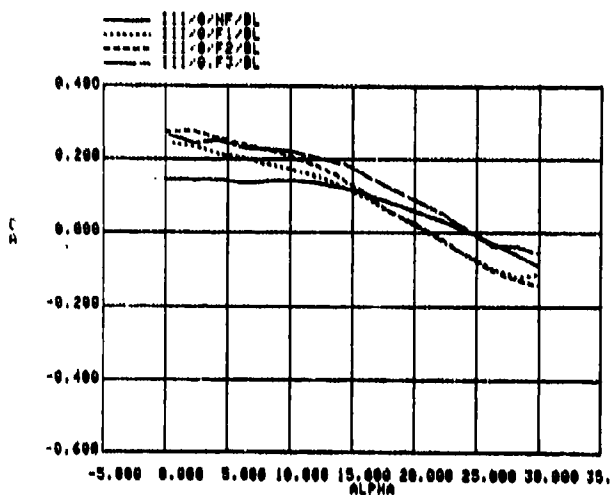


FIGURE A-13.2 FIN EFFECTS

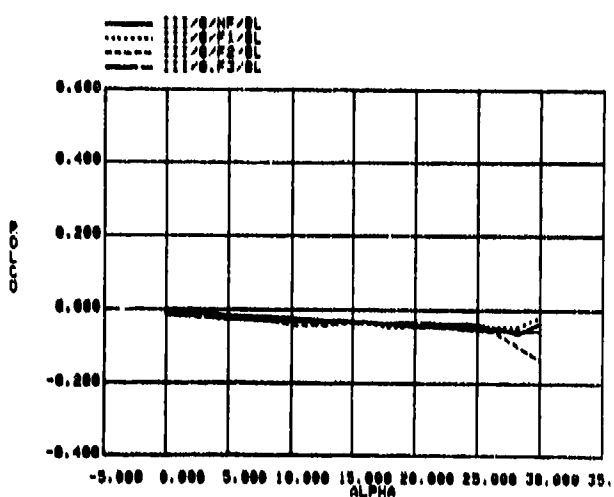


FIGURE A-13.5 FIN EFFECTS

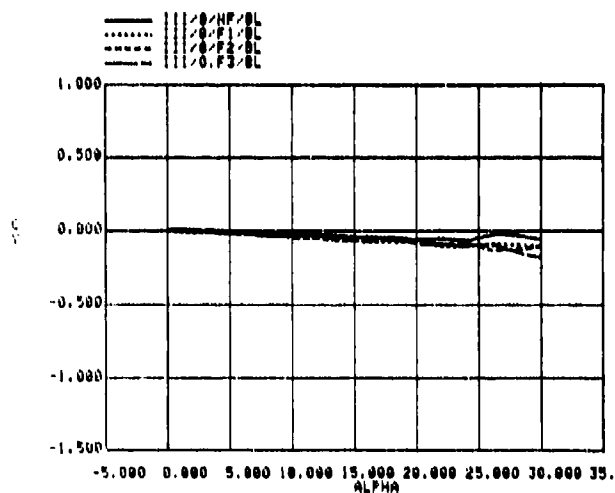


FIGURE A-13.3 FIN EFFECTS

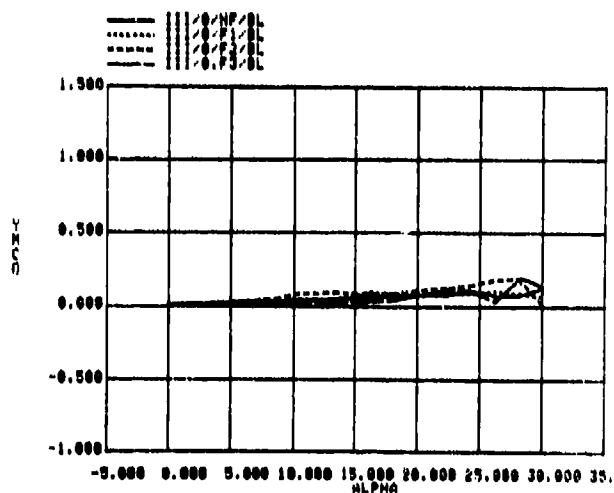


FIGURE A-13.6 FIN EFFECTS

FIGURE A-13. BODY AXIS FORCE & MOMENT FIN EFFECTS, MISSILE III.  
ROLL 0, BLUNT NOSE.

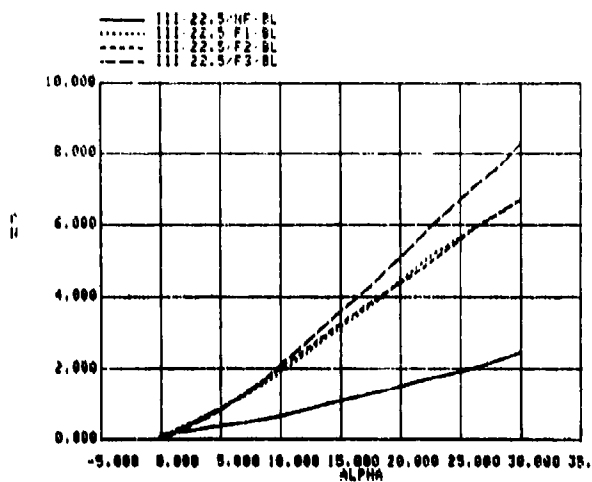


FIGURE A-14.1 FIN EFFECTS

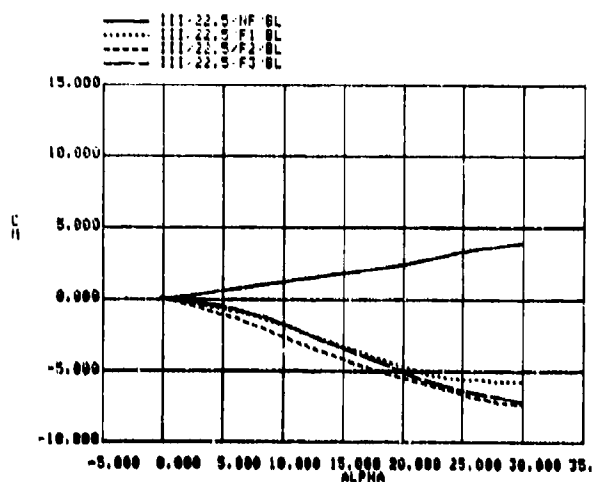


FIGURE A-14.4 FIN EFFECTS

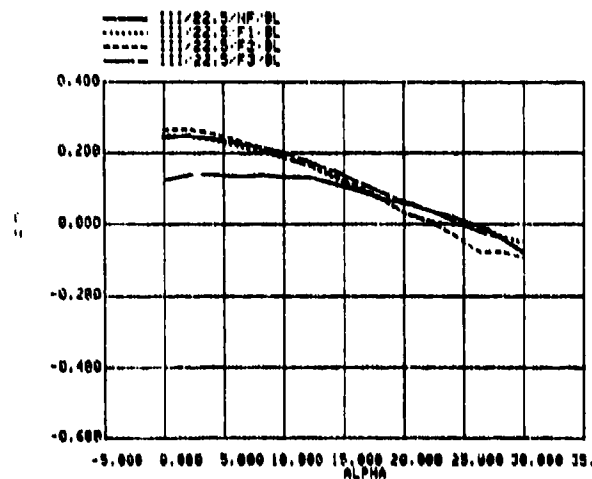


FIGURE A-14.2 FIN EFFECTS

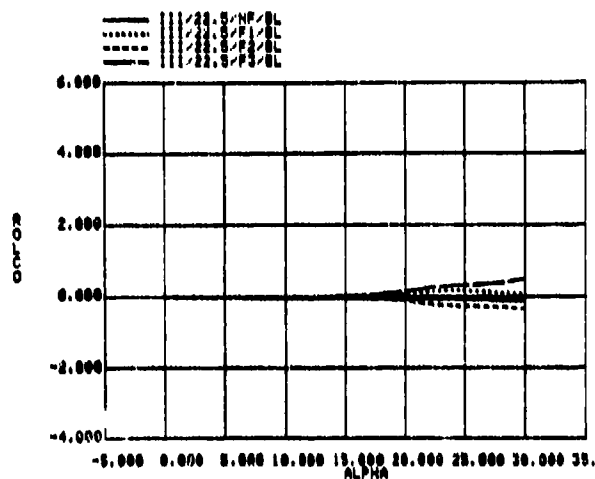


FIGURE A-14.5 FIN EFFECTS

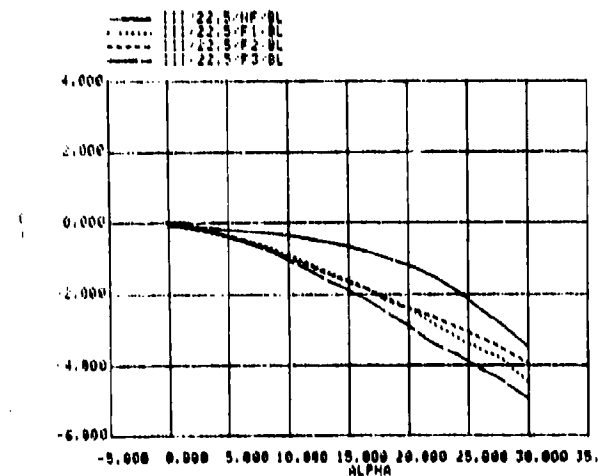


FIGURE A-14.3 FIN EFFECTS

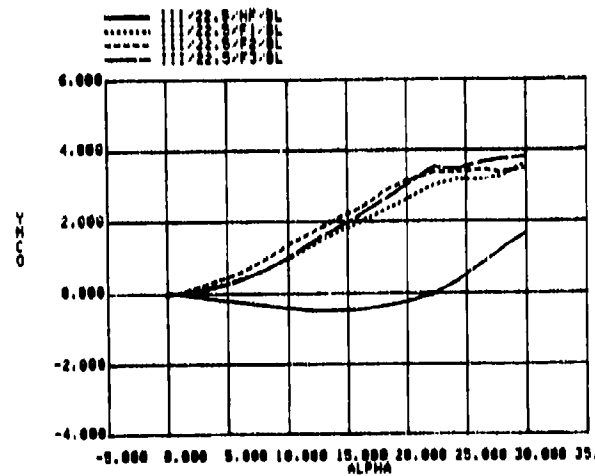


FIGURE A-14.6 FIN EFFECTS

FIGURE A-14. BODY AXIS FORCE & MOMENT FIN EFFECTS, MISSILE III.  
ROLL 22, BLUNT NOSE.



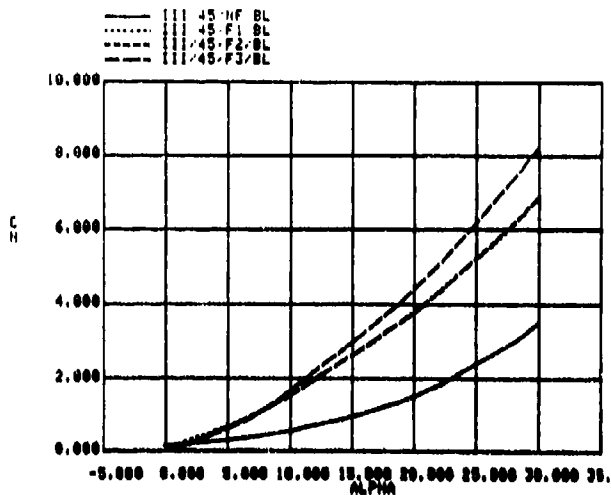


FIGURE A-15.1 FIN EFFECTS

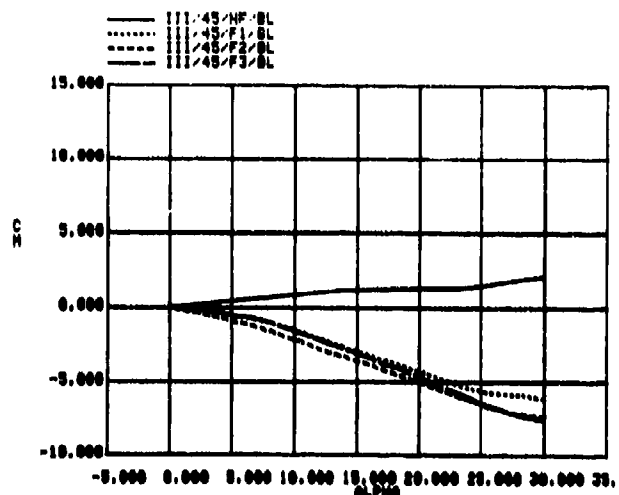


FIGURE A-15.4 FIN EFFECTS

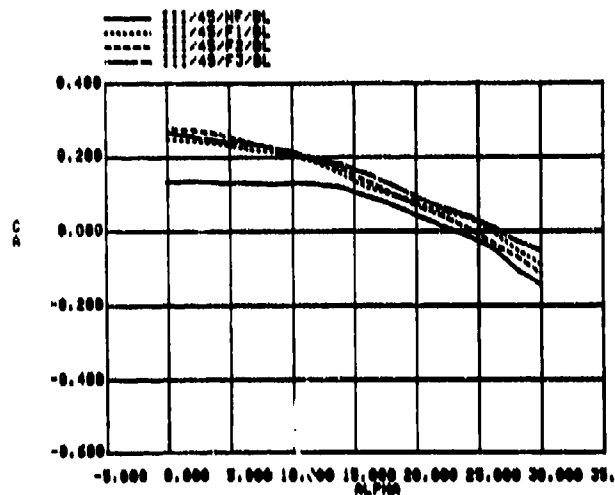


FIGURE A-15.2 FIN EFFECTS

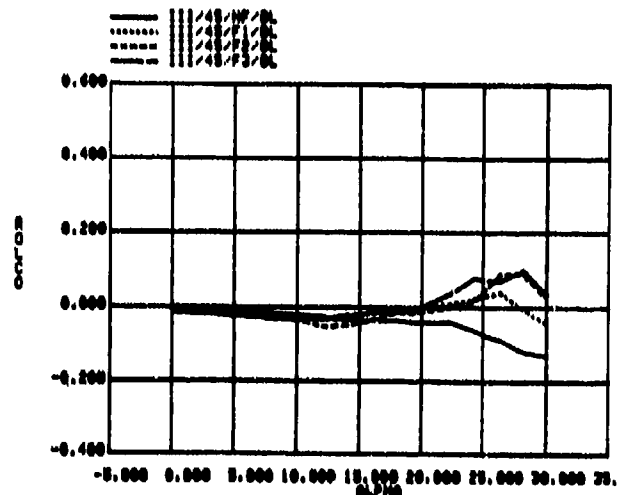


FIGURE A-15.5 FIN EFFECTS

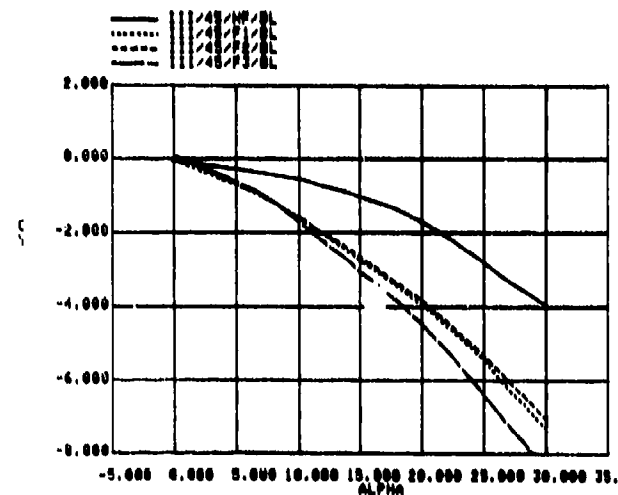


FIGURE A-15.3 FIN EFFECTS

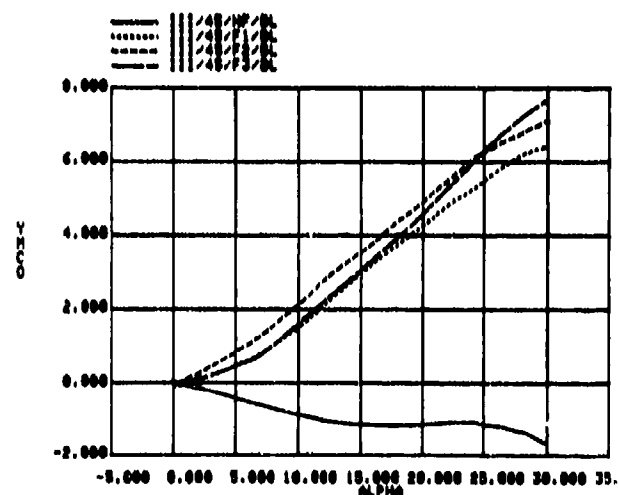


FIGURE A-15.6 FIN EFFECTS

FIGURE A-15. BODY AXIS FORCE & MOMENT FIN EFFECTS, MISSILE III.  
ROLL 45, BLUNT NOSE.

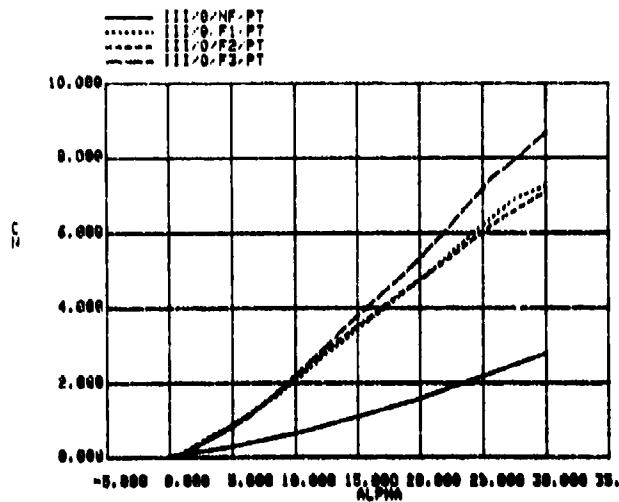


FIGURE A-16.1 FIN EFFECTS

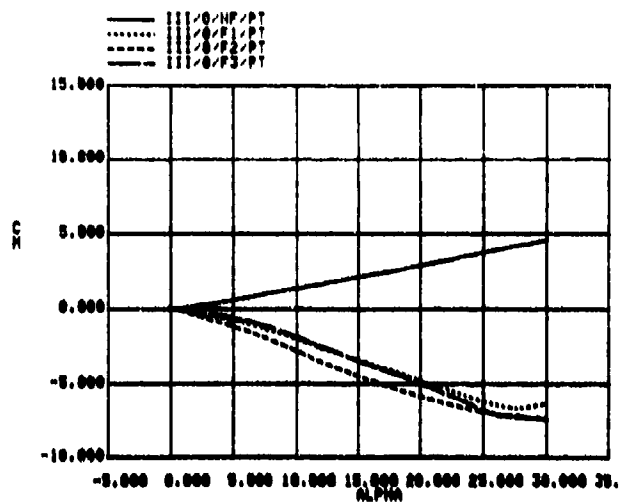


FIGURE A-16.4 FIN EFFECTS

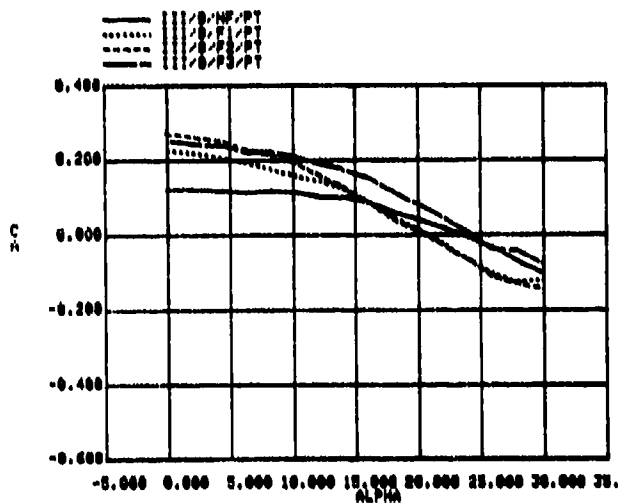


FIGURE A-16.2 FIN EFFECTS

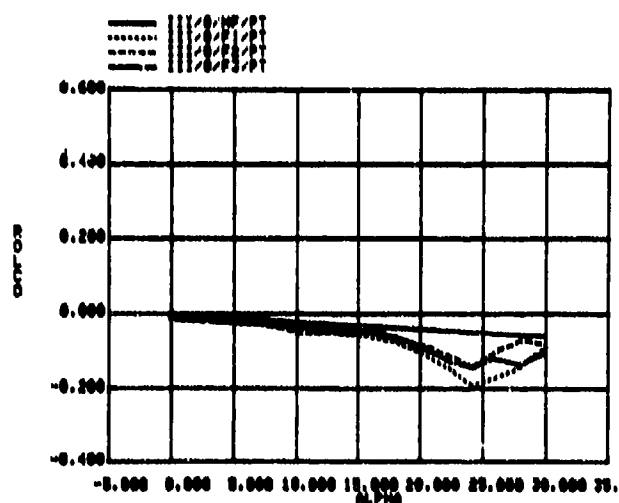


FIGURE A-16.5 FIN EFFECTS

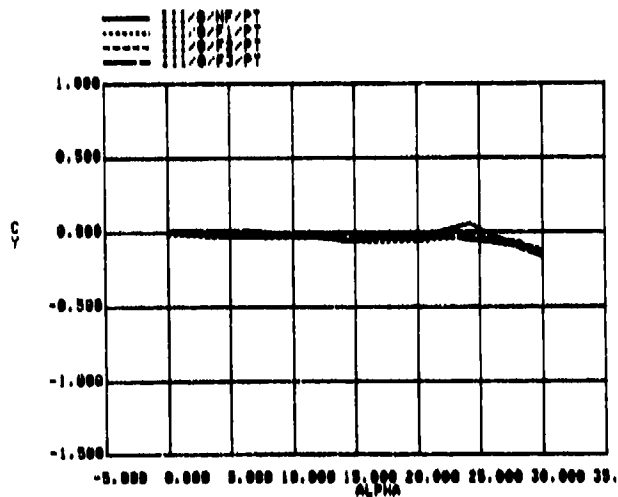


FIGURE A-16.3 FIN EFFECTS

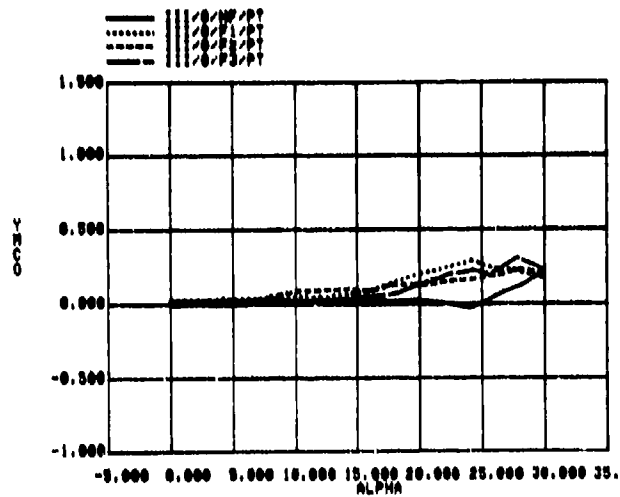


FIGURE A-16.6 FIN EFFECTS

FIGURE A-16. BODY AXIS FORCE & MOMENT FIN EFFECTS, MISSILE III.  
ROLL 0, POINTED NOSE.

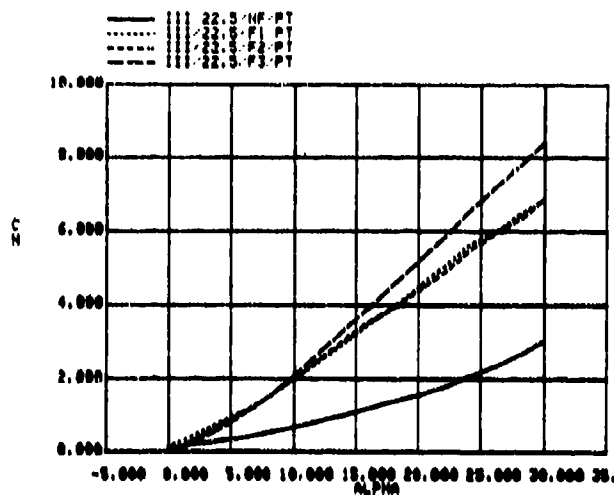


FIGURE A-17.1 FIN EFFECTS

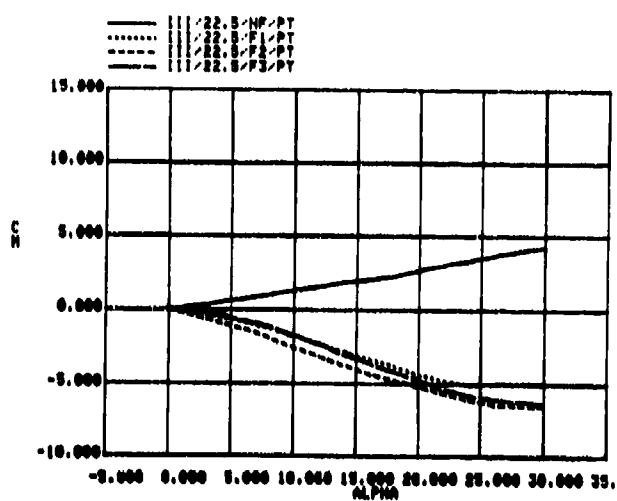


FIGURE A-17.4 FIN EFFECTS

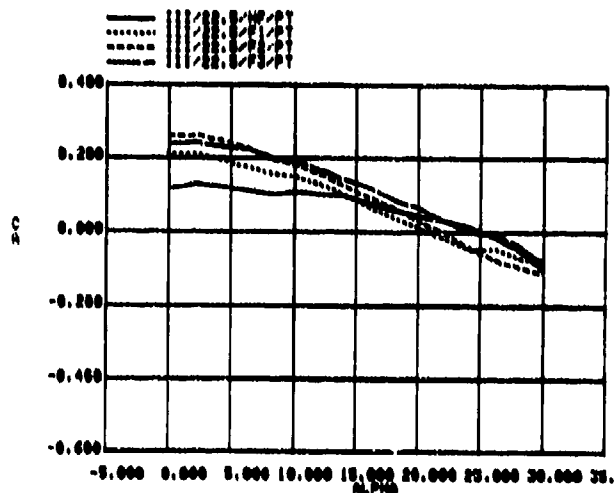


FIGURE A-17.2 FIN EFFECTS

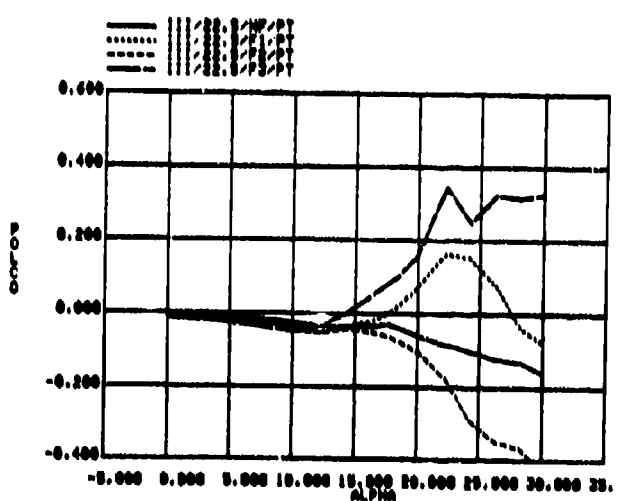


FIGURE A-17.5 FIN EFFECTS

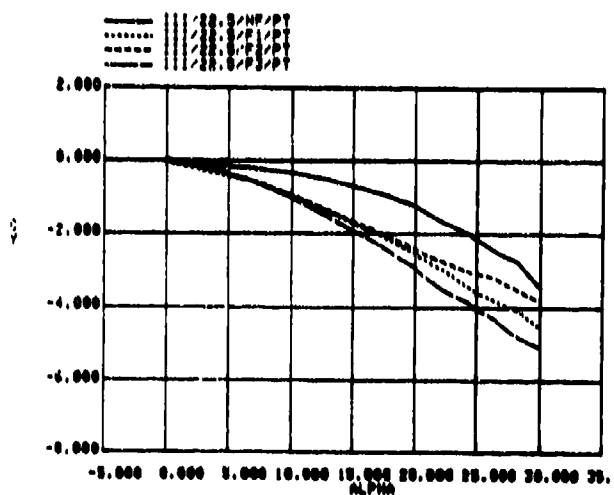


FIGURE A-17.3 FIN EFFECTS

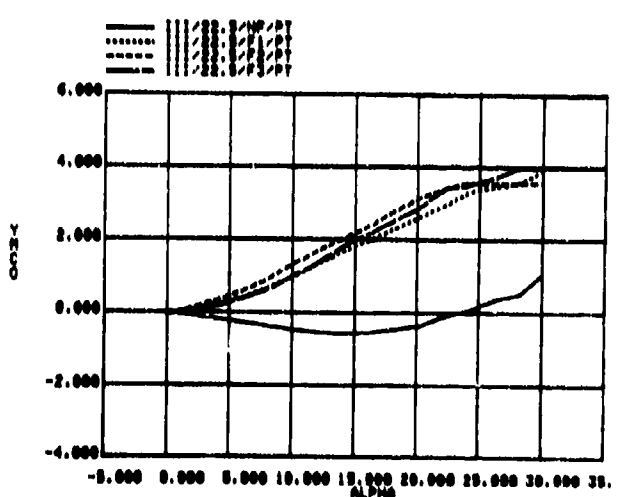


FIGURE A-17.6 FIN EFFECTS

FIGURE A-17. BODY AXIS FORCE & MOMENT FIN EFFECTS, MISSILE III.  
ROLL 22, POINTED NOSE.

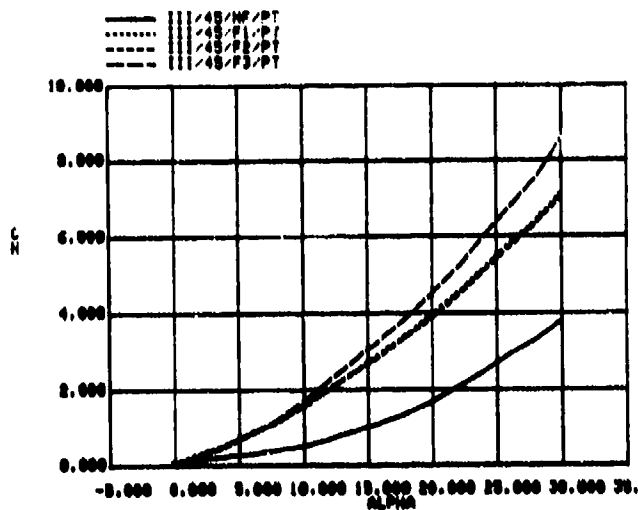


FIGURE A-18.1 FIN EFFECTS

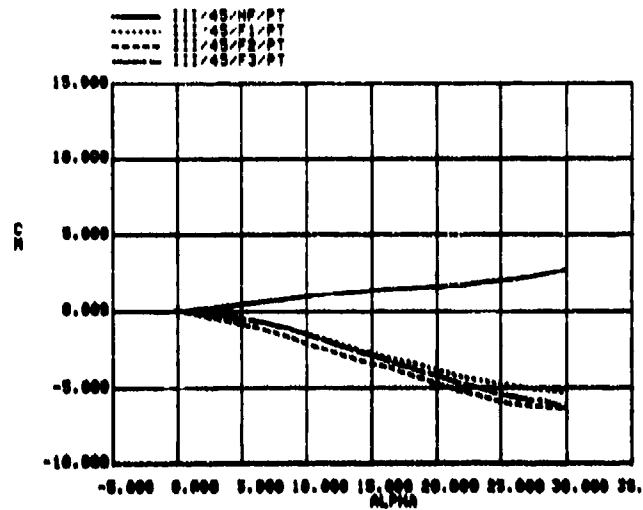


FIGURE A-18.4 FIN EFFECTS

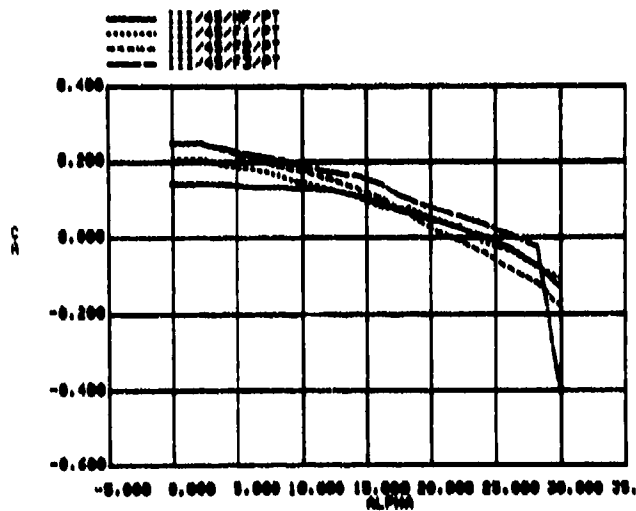


FIGURE A-18.2 FIN EFFECTS

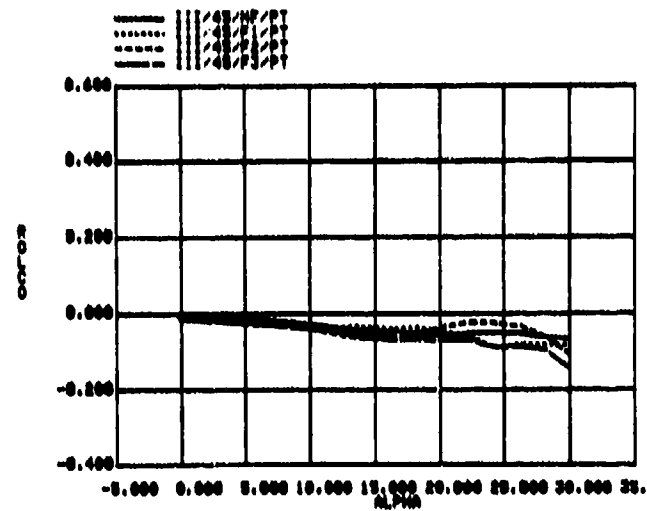


FIGURE A-18.5 FIN EFFECTS

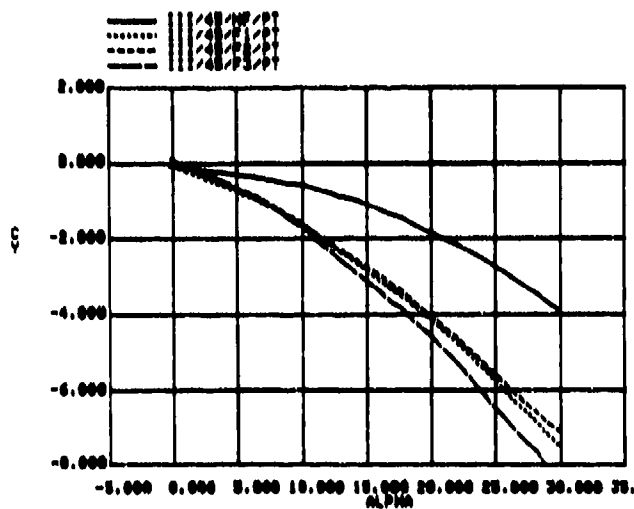


FIGURE A-18.3 FIN EFFECTS

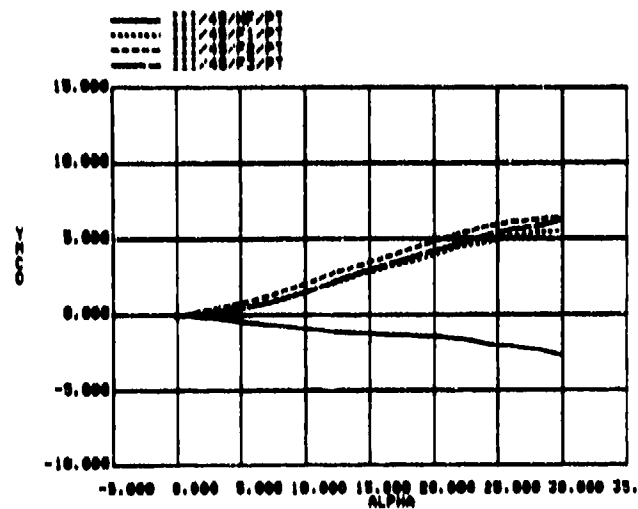


FIGURE A-18.6 FIN EFFECTS

FIGURE A-18. BODY AXIS FORCE & MOMENT FIN EFFECTS, MISSILE III.  
ROLL 45, POINTED NOSE.

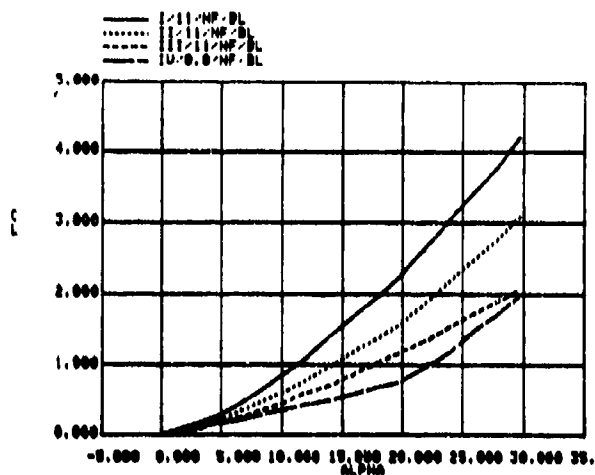


FIGURE A-19.1 BODY CORNER RADIUS EFFECTS

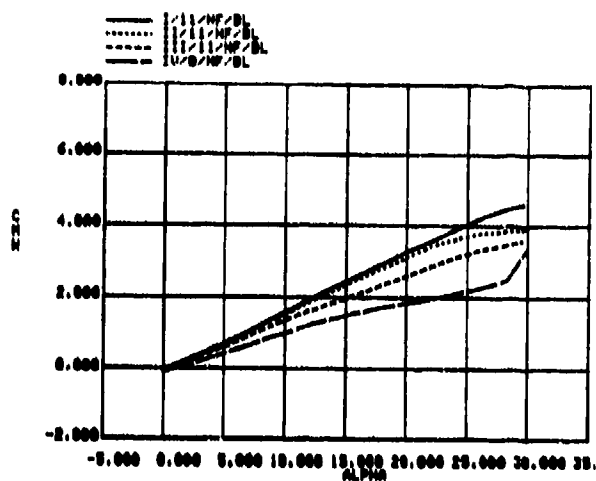


FIGURE A-19.4 BODY CORNER RADIUS EFFECTS

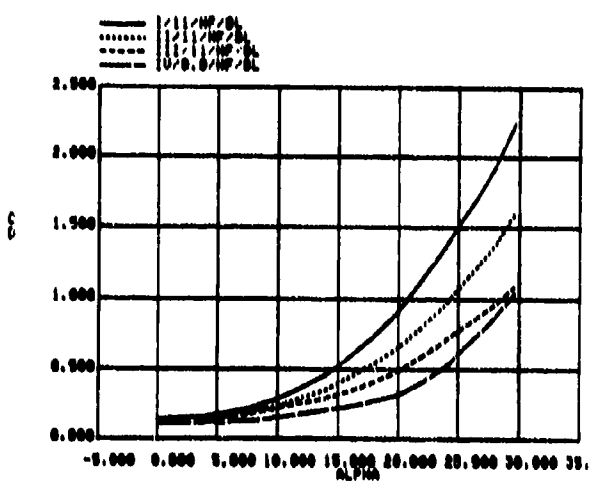


FIGURE A-19.2 BODY CORNER RADIUS EFFECTS

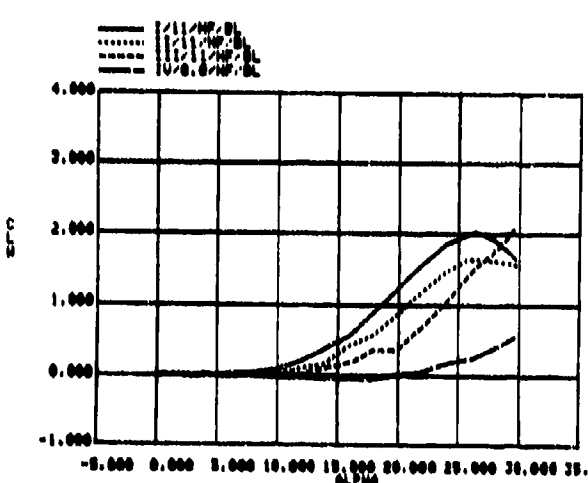


FIGURE A-19.5 BODY CORNER RADIUS EFFECTS

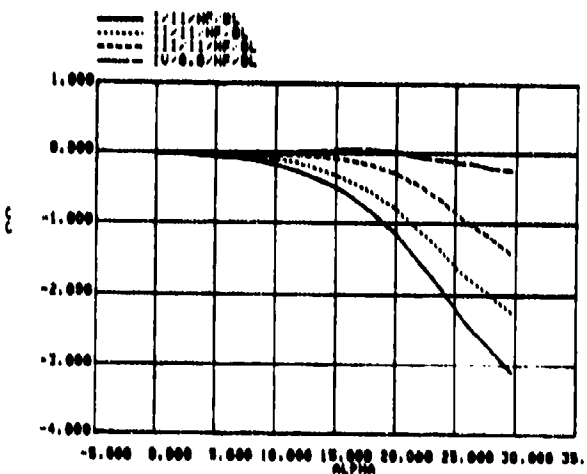


FIGURE A-19.3 BODY CORNER RADIUS EFFECTS

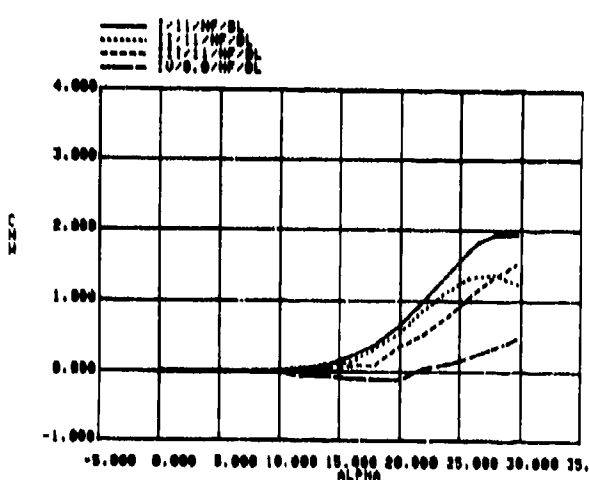


FIGURE A-19.6 BODY CORNER RADIUS EFFECTS

FIGURE A-19. WIND AXIS FORCE & MOMENT BODY EFFECTS, 11 ROLL ANGLE.  
NO FINS, BLUNT NOSE.

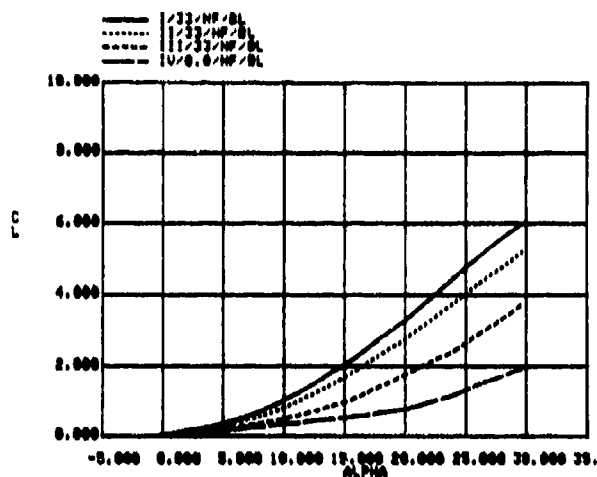


FIGURE A-20.1 BODY CORNER RADIUS EFFECTS

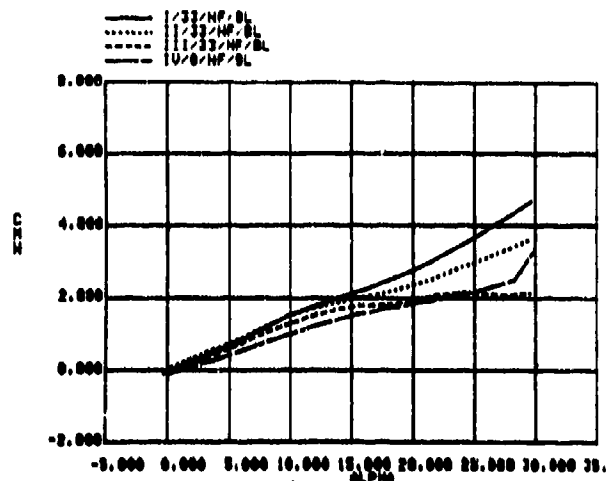


FIGURE A-20.4 BODY CORNER RADIUS EFFECTS

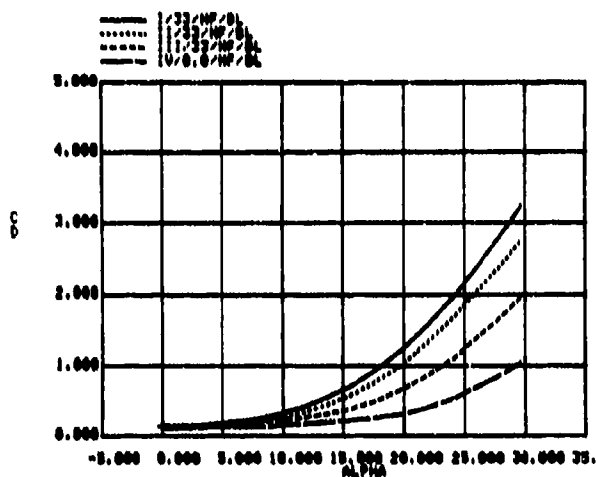


FIGURE A-20.2 BODY CORNER RADIUS EFFECTS

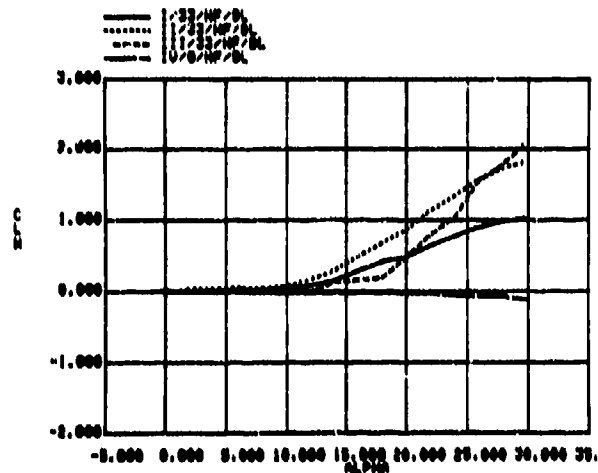


FIGURE A-20.5 BODY CORNER RADIUS EFFECTS

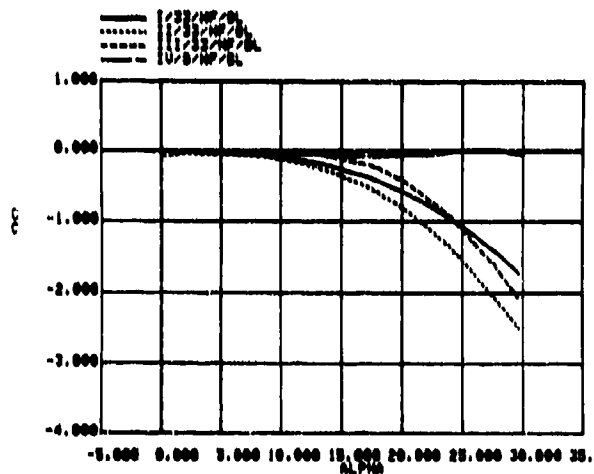


FIGURE A-20.3 BODY CORNER RADIUS EFFECTS

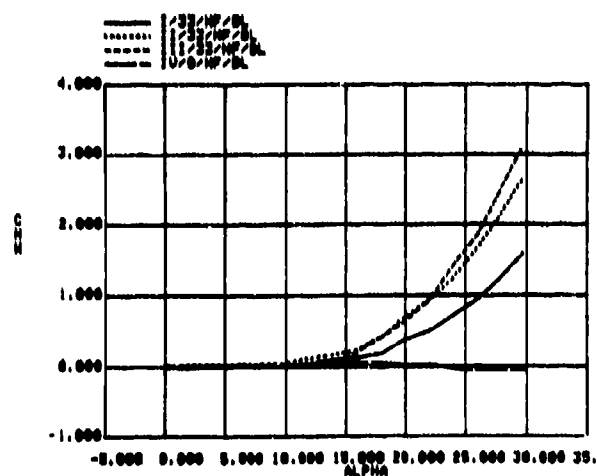


FIGURE A-20.6 BODY CORNER RADIUS EFFECTS

FIGURE A-20. WIND AXIS FORCE & MOMENT BODY EFFECTS, 33 ROLL ANGLE.  
NO FINS, BLUNT NOSE.

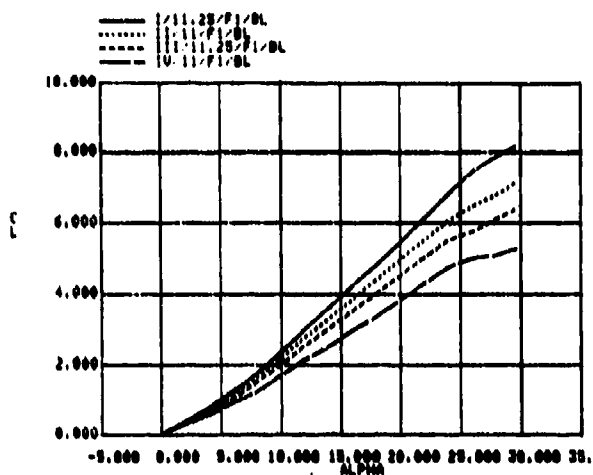


FIGURE A-21.1 BODY CORNER RADIUS EFFECTS

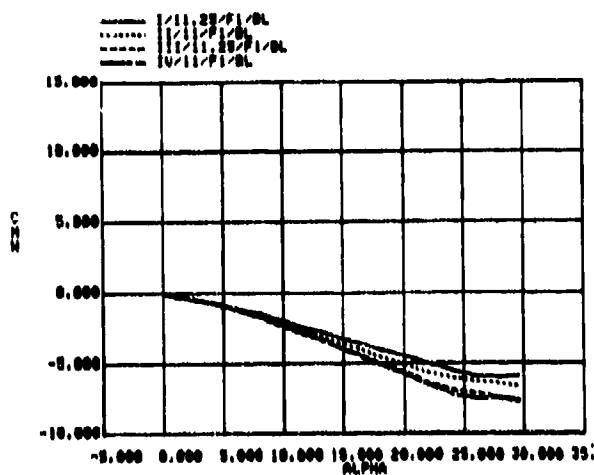


FIGURE A-21.4 BODY CORNER RADIUS EFFECTS

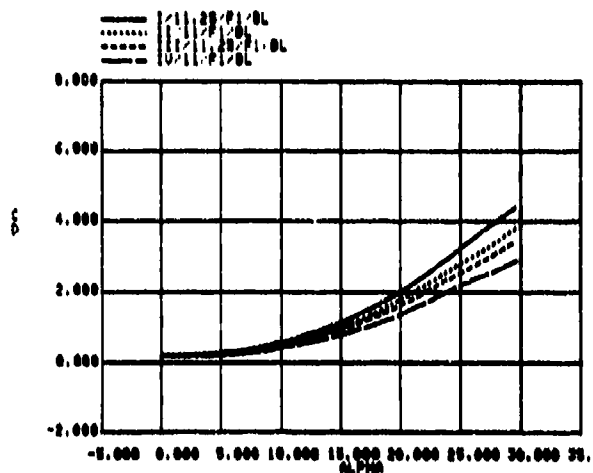


FIGURE A-21.2 BODY CORNER RADIUS EFFECTS

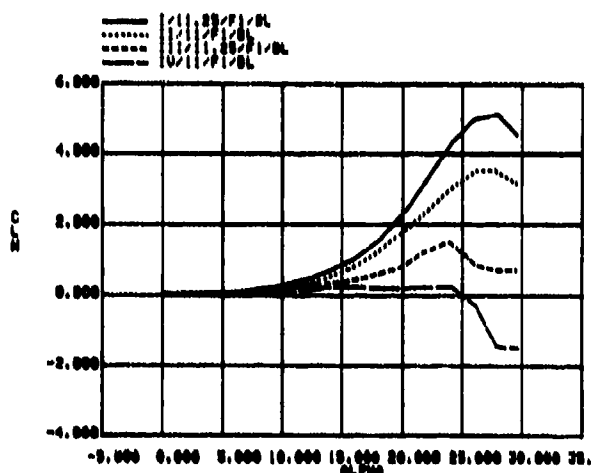


FIGURE A-21.5 BODY CORNER RADIUS EFFECTS

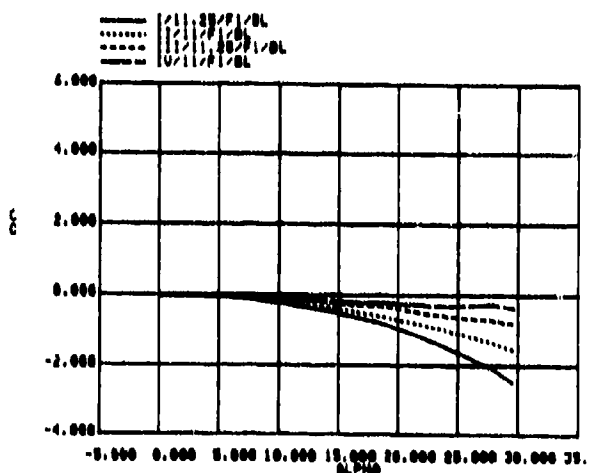


FIGURE A-21.3 BODY CORNER RADIUS EFFECTS

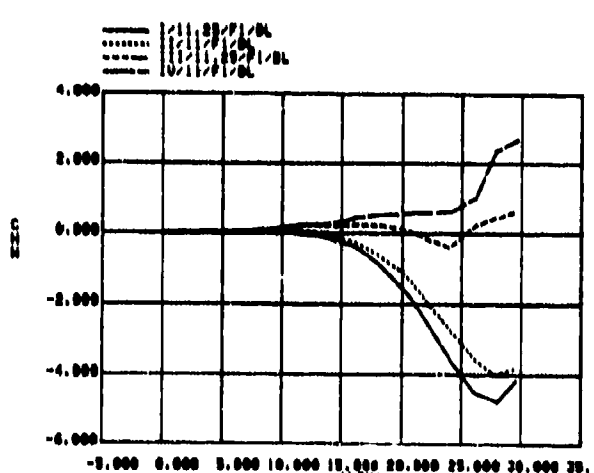


FIGURE A-21.6 BODY CORNER RADIUS EFFECTS

FIGURE A-21. WIND AXIS FORCE & MOMENT BODY EFFECTS, 11 ROLL ANGLE.  
FIN 1, BLUNT NOSE.

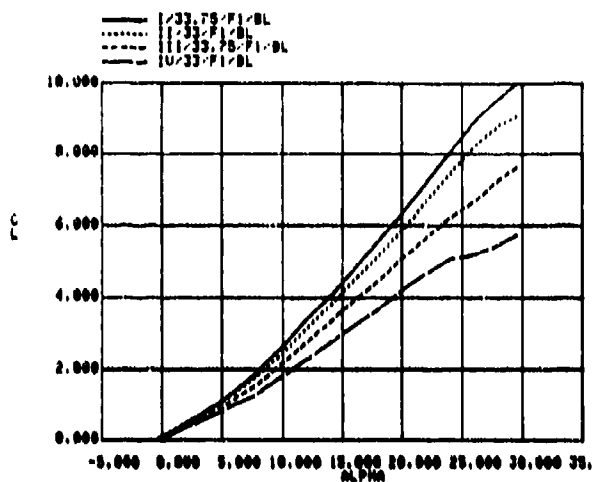


FIGURE A-22.1 BODY CORNER RADIUS EFFECTS

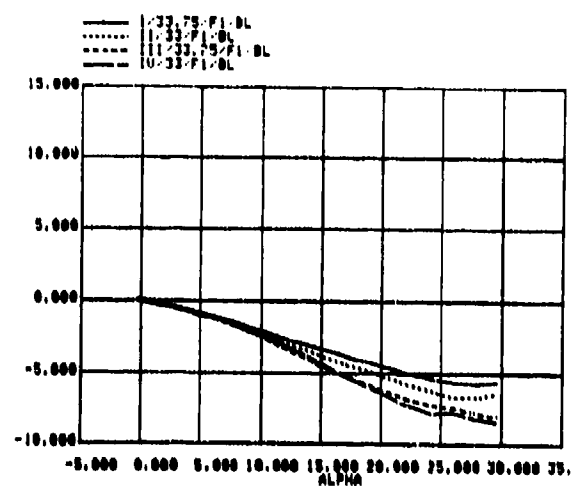


FIGURE A-22.4 BODY CORNER RADIUS EFFECTS

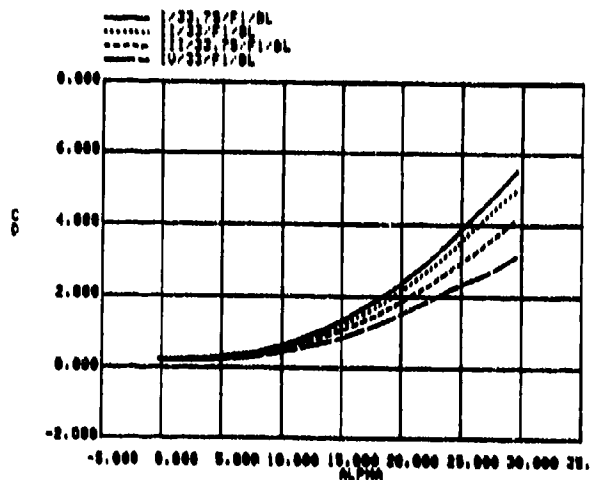


FIGURE A-22.2 BODY CORNER RADIUS EFFECTS

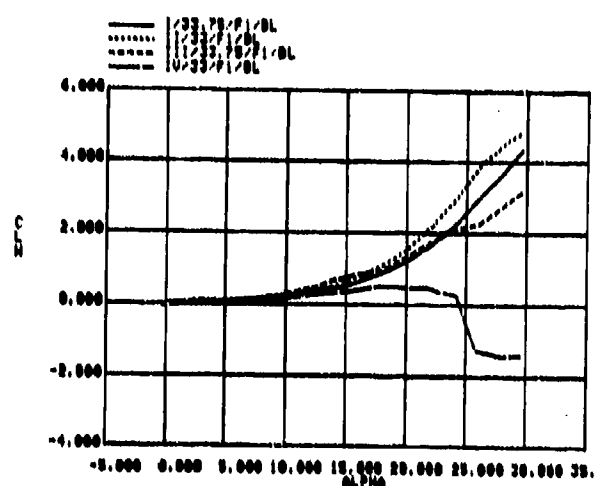


FIGURE A-22.5 BODY CORNER RADIUS EFFECTS

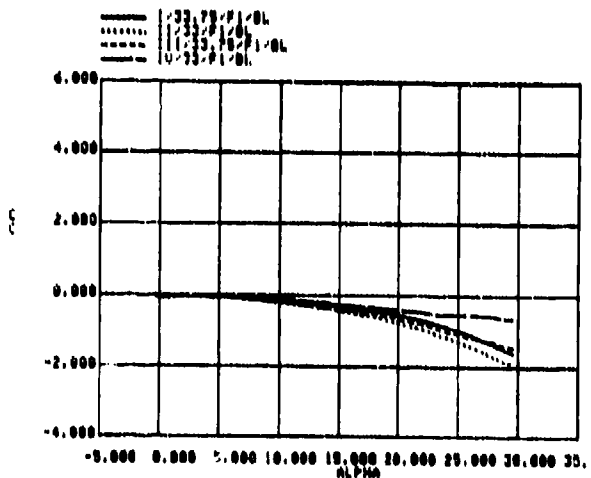


FIGURE A-22.3 BODY CORNER RADIUS EFFECTS

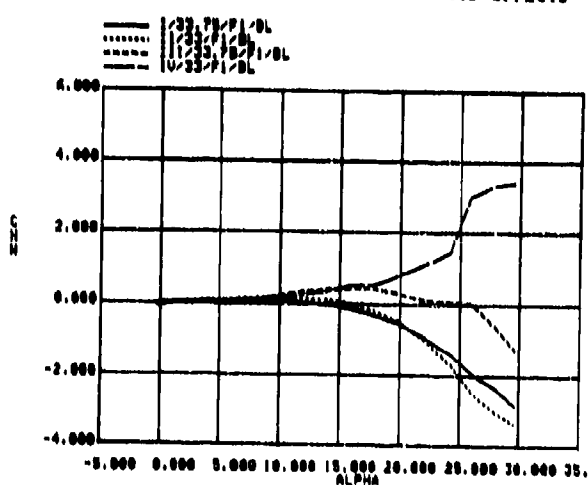


FIGURE A-22.6 BODY CORNER RADIUS EFFECTS

FIGURE A-22. WIND AXIS FORCE & MOMENT BODY EFFECTS, 33 ROLL ANGLE.  
FIN 1, BLUNT NOSE.



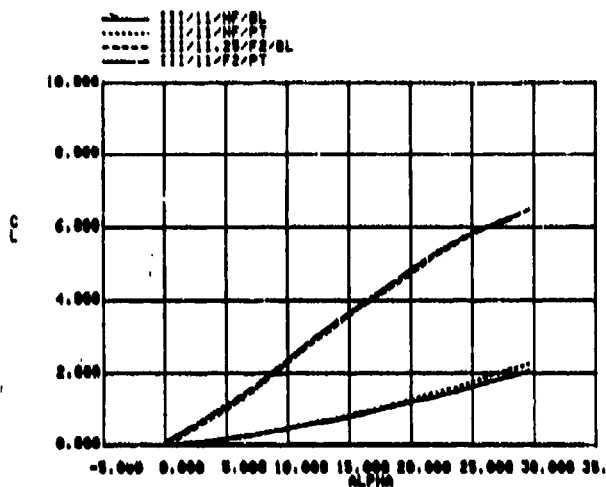


FIGURE A-23.1 NOSE EFFECTS

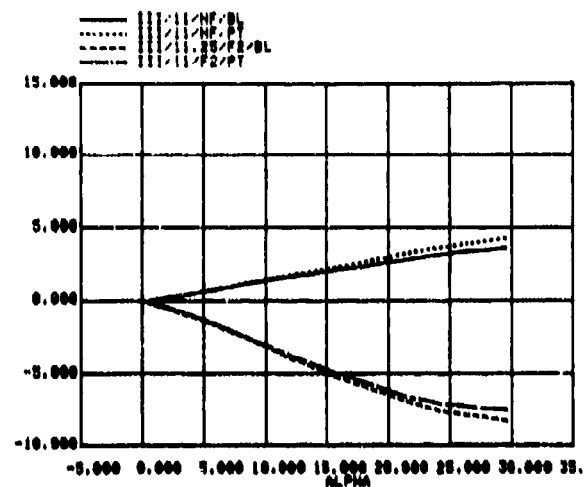


FIGURE A-23.4 NOSE EFFECTS

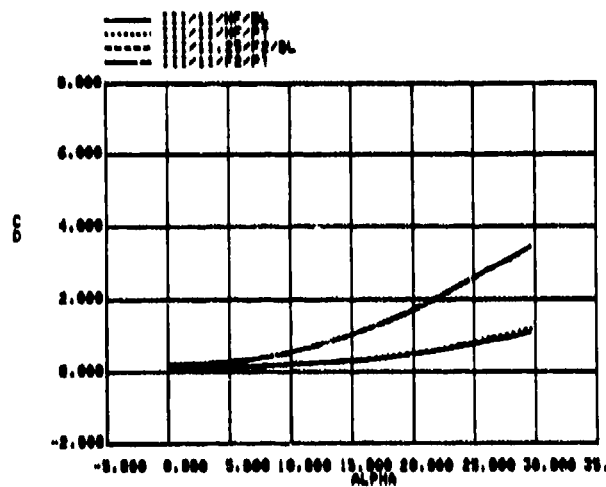


FIGURE A-23.2 NOSE EFFECTS

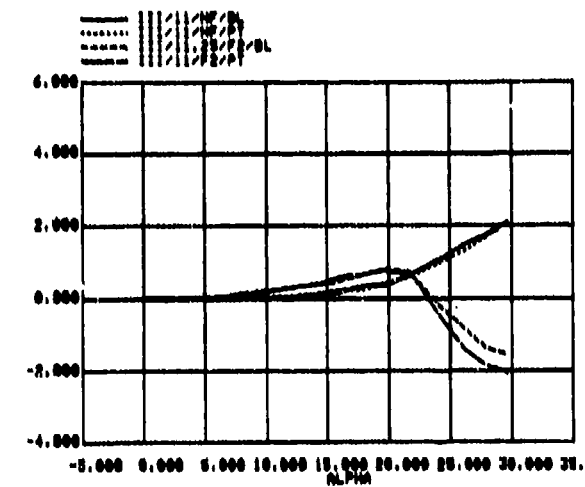


FIGURE A-23.5 NOSE EFFECTS

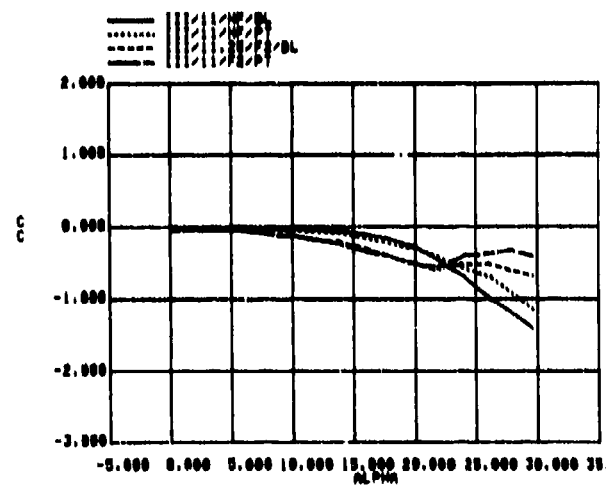


FIGURE A-23.3 NOSE EFFECTS

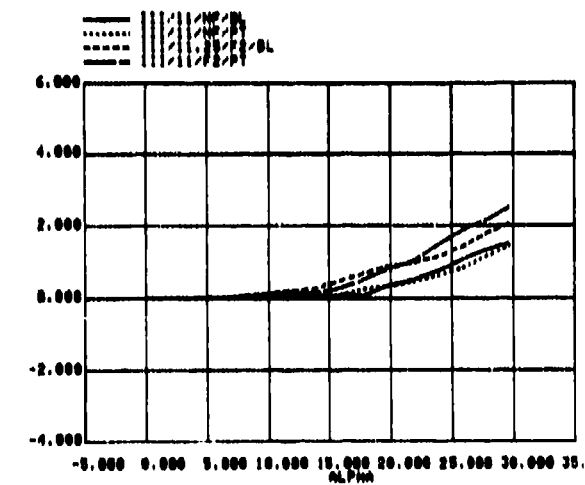


FIGURE A-23.6 NOSE EFFECTS

FIGURE A-23. WIND AXIS FORCE & MOMENT NOSE EFFECTS, MISSILE III,  
ROLL 11, NO FIN/FIN 2, BLUNT/POINTED NOSE.

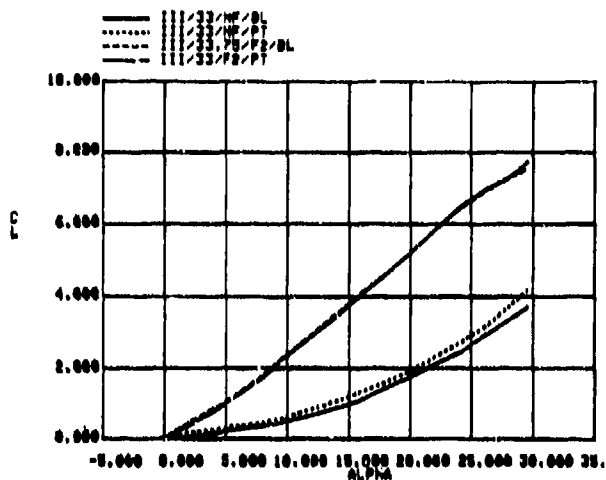


FIGURE A-24.1 NOSE EFFECTS

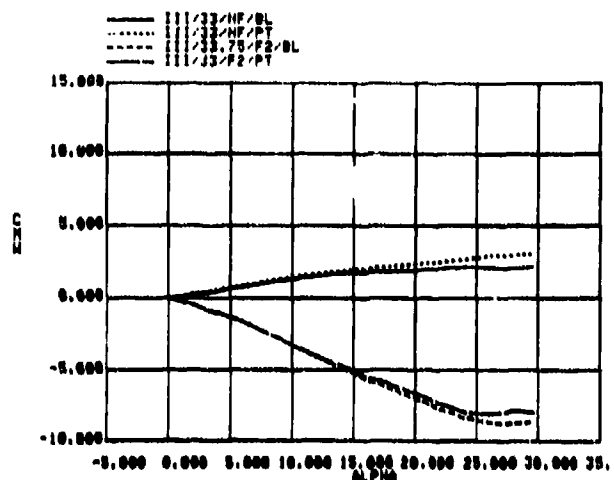


FIGURE A-24.4 NOSE EFFECTS

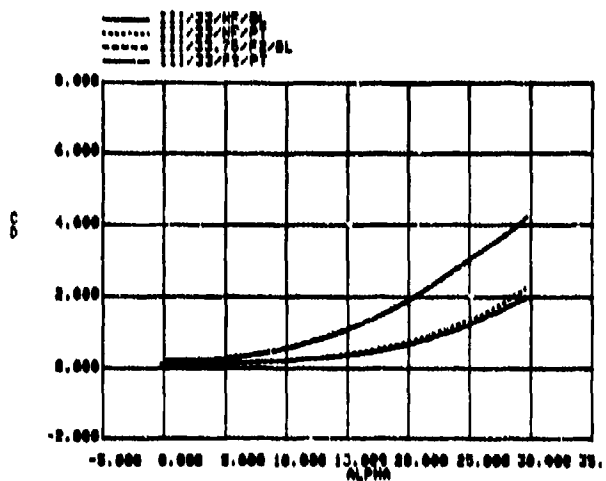


FIGURE A-24.2 NOSE EFFECTS

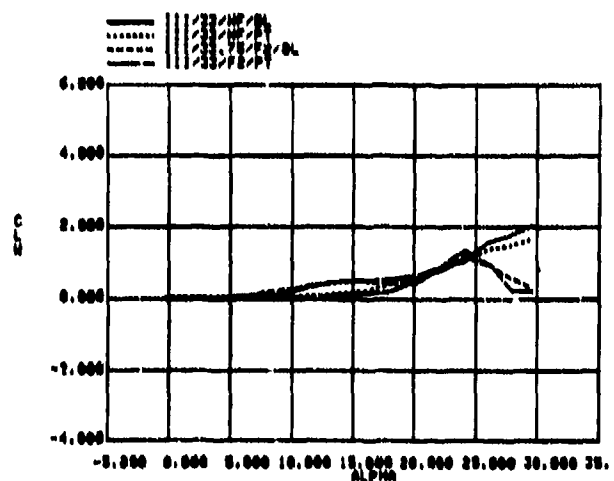


FIGURE A-24.5 NOSE EFFECTS

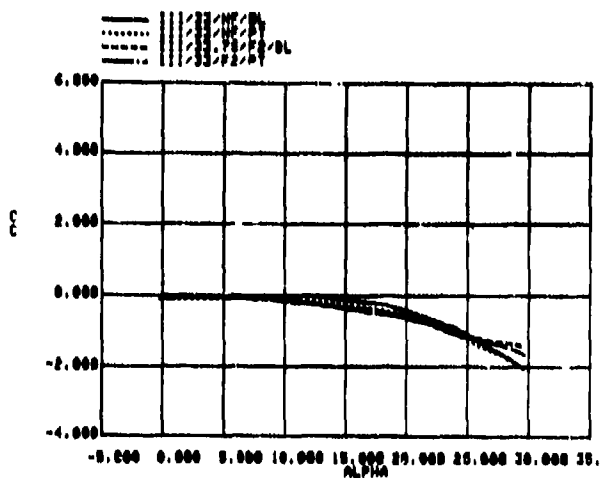


FIGURE A-24.3 NOSE EFFECTS

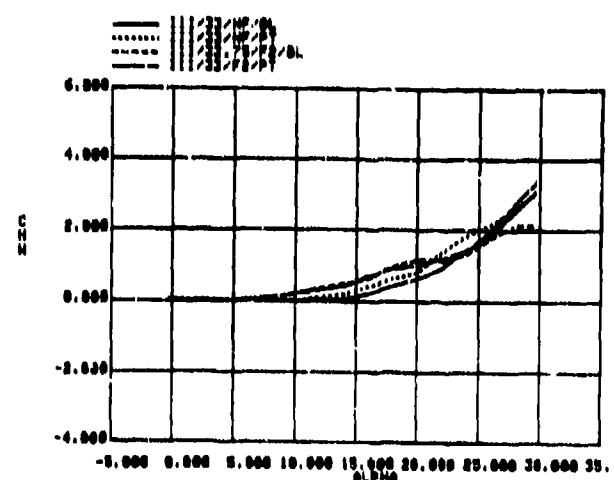


FIGURE A-24.6 NOSE EFFECTS

FIGURE A-24. WIND AXIS FORCE & MOMENT NOSE EFFECTS, MISSILE III.  
ROLL 33, NO FIN/FIN 2, BLUNT/POINTED NOSE.

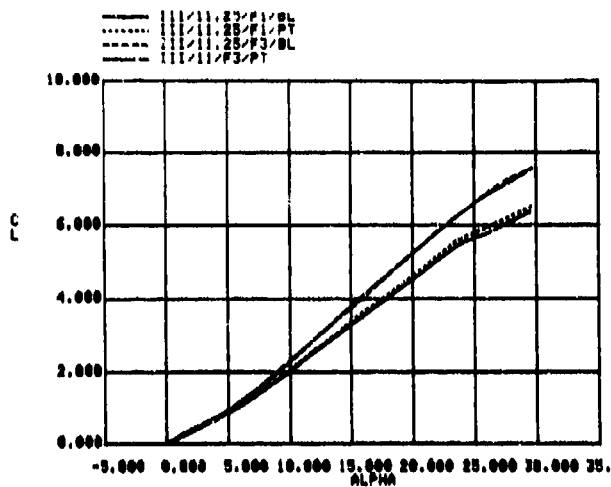


FIGURE A-25.1 NOSE EFFECTS

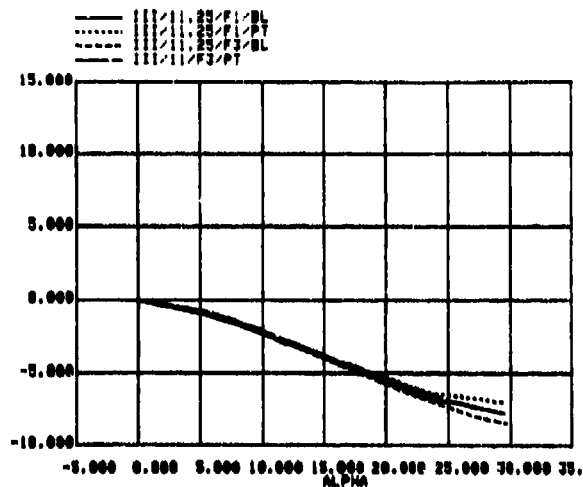


FIGURE A-25.4 NOSE EFFECTS

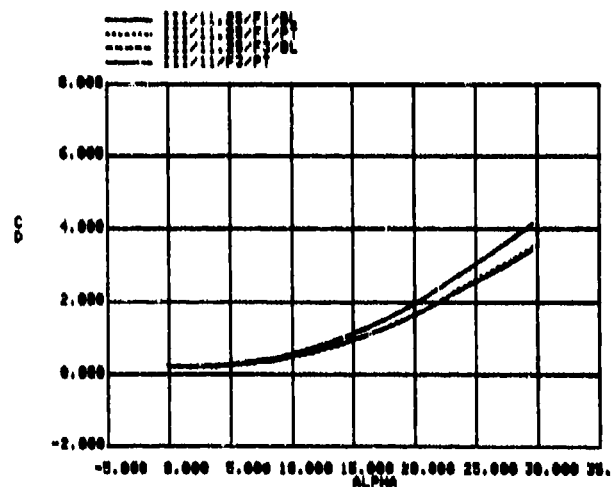


FIGURE A-25.2 NOSE EFFECTS

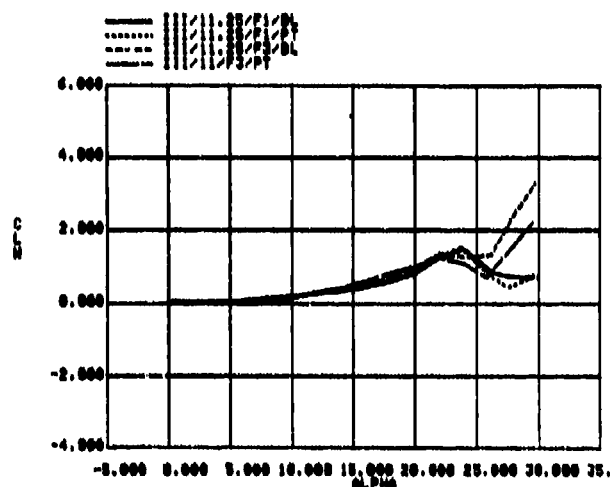


FIGURE A-25.5 NOSE EFFECTS

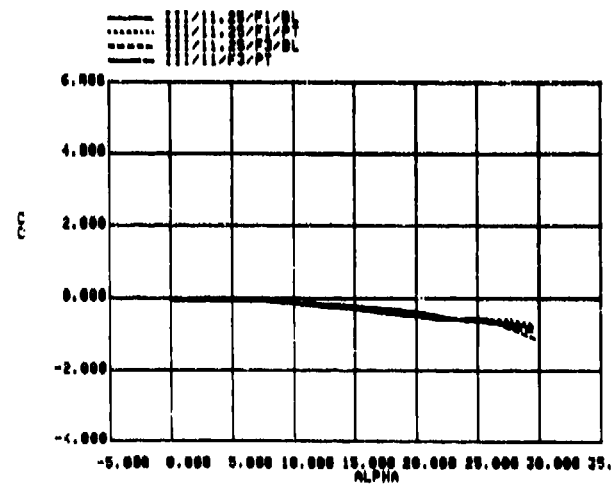


FIGURE A-25.3 NOSE EFFECTS

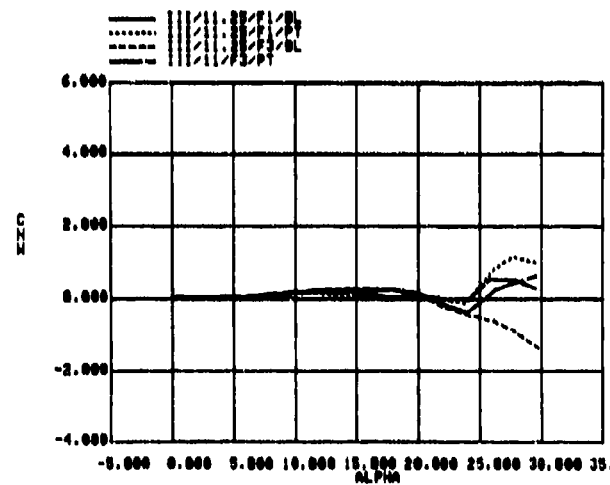


FIGURE A-25.6 NOSE EFFECTS

FIGURE A-25. WIND AXIS FORCE & MOMENT NOSE EFFECTS, MISSILE III.  
ROLL 11, FIN 1/FIN 3, BLUNT/POINTED NOSE.

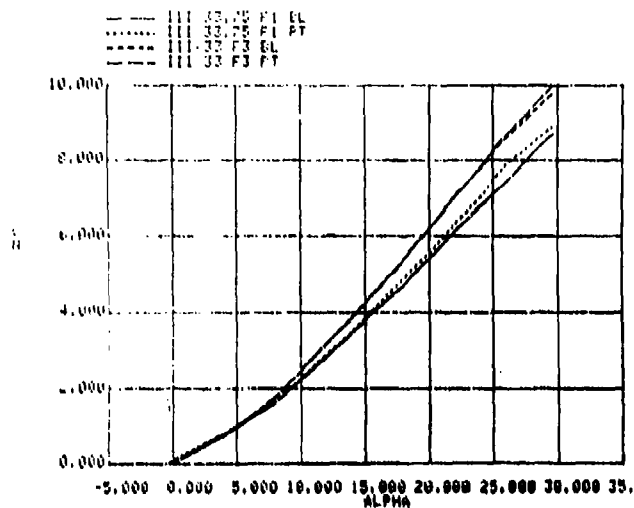


FIGURE A-26.1 NOSE EFFECTS

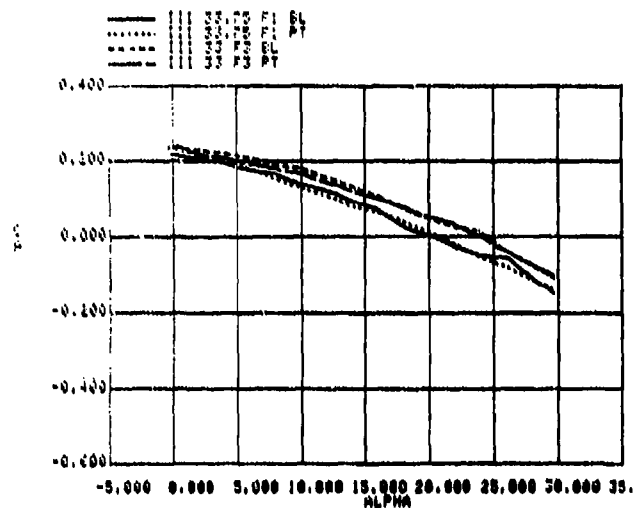


FIGURE A-26.2 NOSE EFFECTS

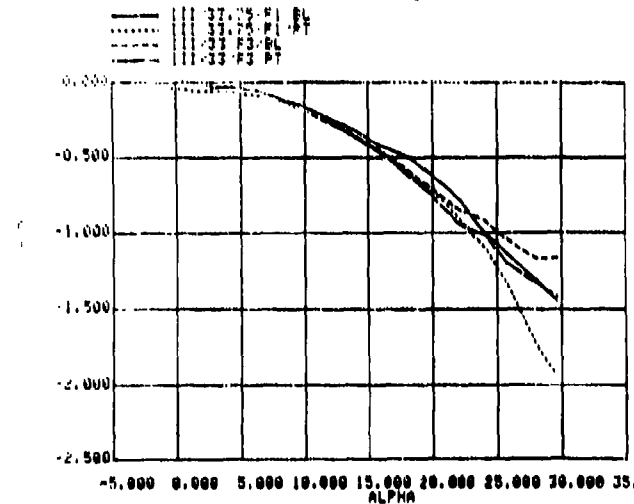


FIGURE A-26.3 NOSE EFFECTS

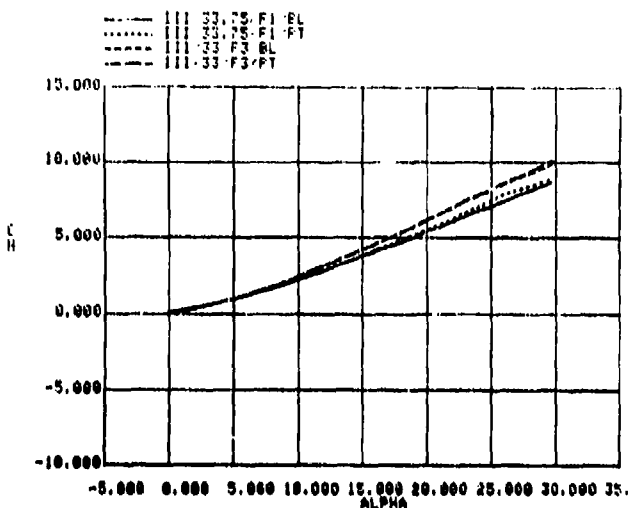


FIGURE A-26.4 NOSE EFFECTS

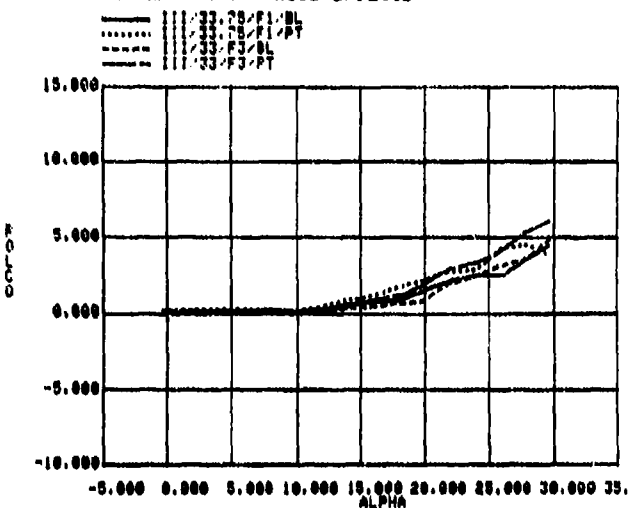


FIGURE A-26.5 NOSE EFFECTS

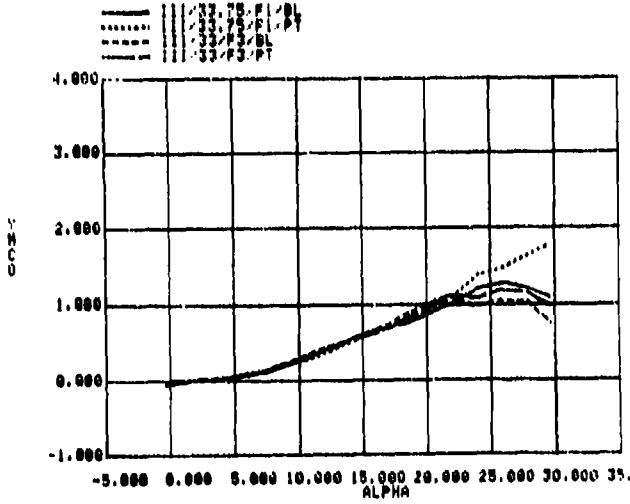


FIGURE A-26.6 NOSE EFFECTS

FIGURE A-26. WIND AXIS FORCE & MOMENT NOSE EFFECTS, MISSILE III.  
ROLL 33, FIN 1/FIN 3, BLUNT/POINTED NOSE.

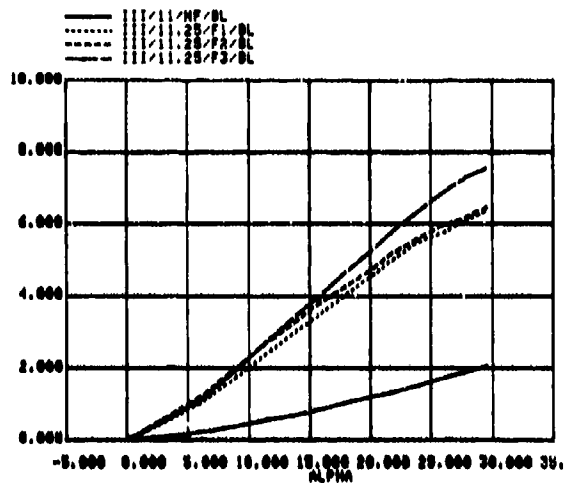


FIGURE A-27.1 FIN EFFECTS

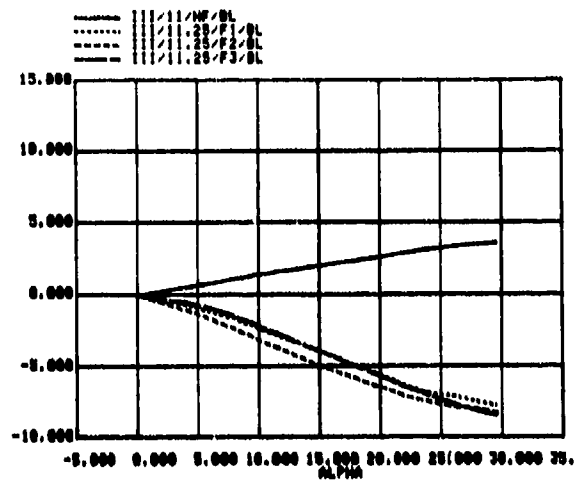


FIGURE A-27.4 FIN EFFECTS

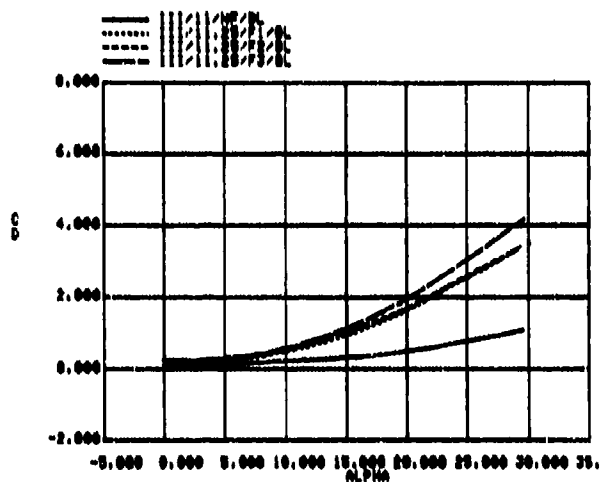


FIGURE A-27.2 FIN EFFECTS

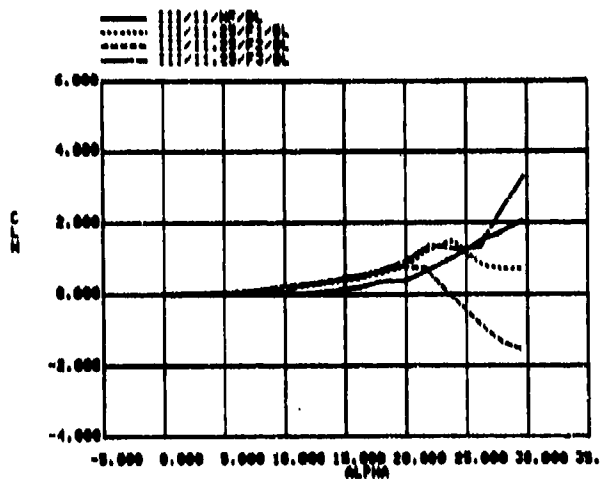


FIGURE A-27.5 FIN EFFECTS

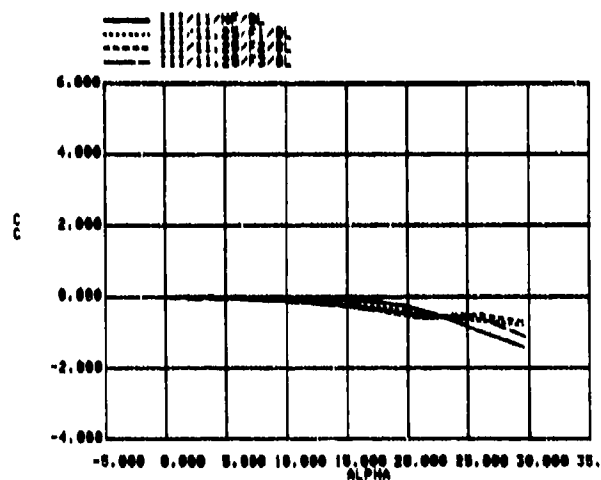


FIGURE A-27.3 FIN EFFECTS

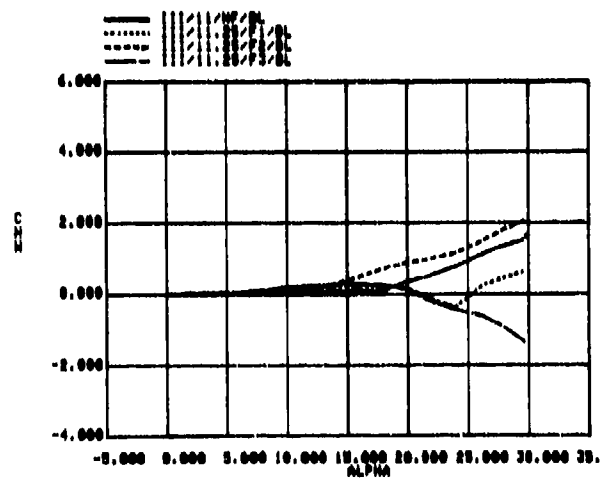


FIGURE A-27.6 FIN EFFECTS

FIGURE A-27. WIND AXIS FORCE & MOMENT FIN EFFECTS, MISSILE III.  
ROLL 11, BLUNT NOSE.

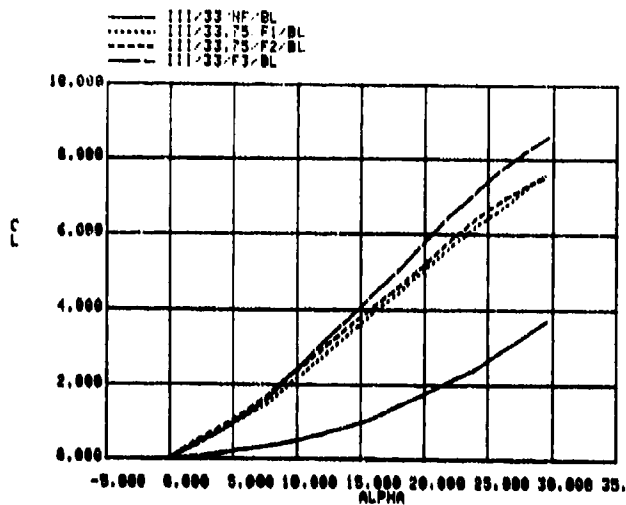


FIGURE A-28.1 FIN EFFECTS

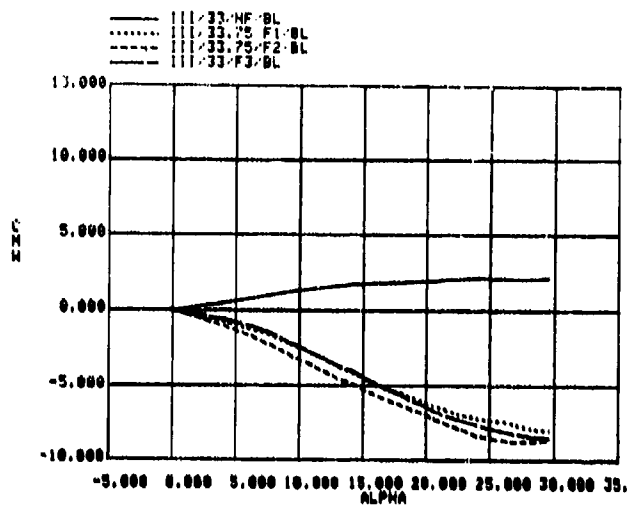


FIGURE A-28.4 FIN EFFECTS

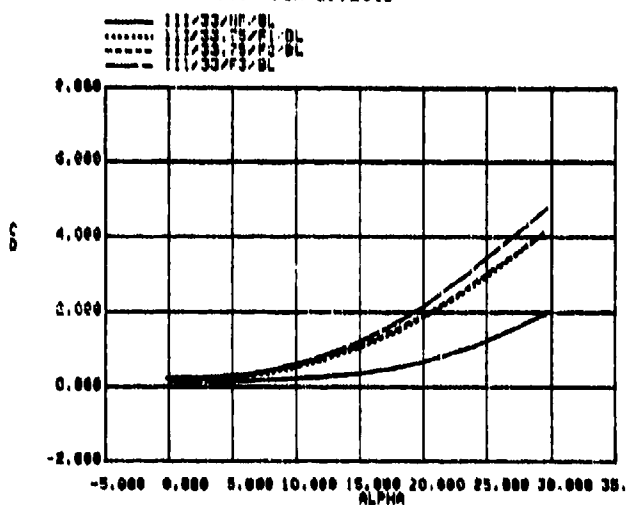


FIGURE A-28.2 FIN EFFECTS

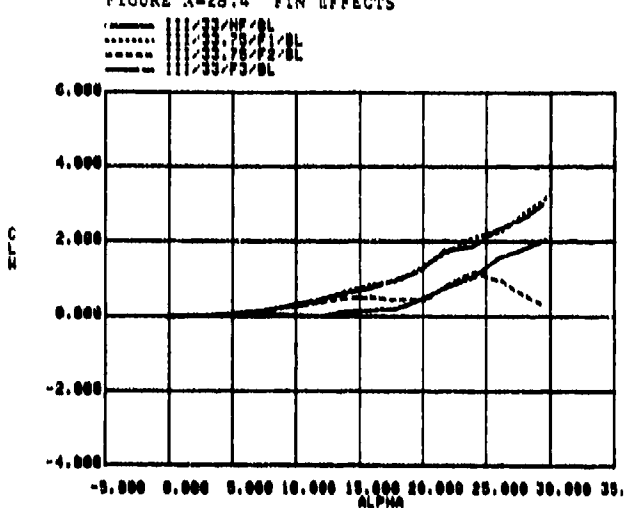


FIGURE A-28.5 FIN EFFECTS

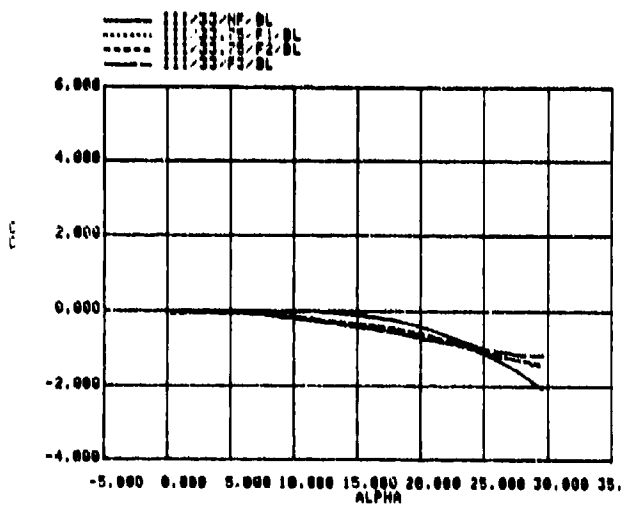


FIGURE A-28.3 FIN EFFECTS

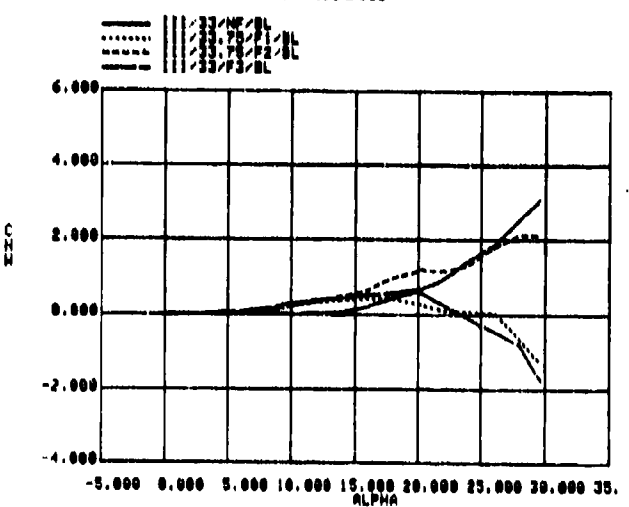


FIGURE A-28.6 FIN EFFECTS

FIGURE A-28. WIND AXIS FORCE & MOMENT FIN EFFECTS, MISSILE III.  
ROLL 33, BLUNT NOSE.

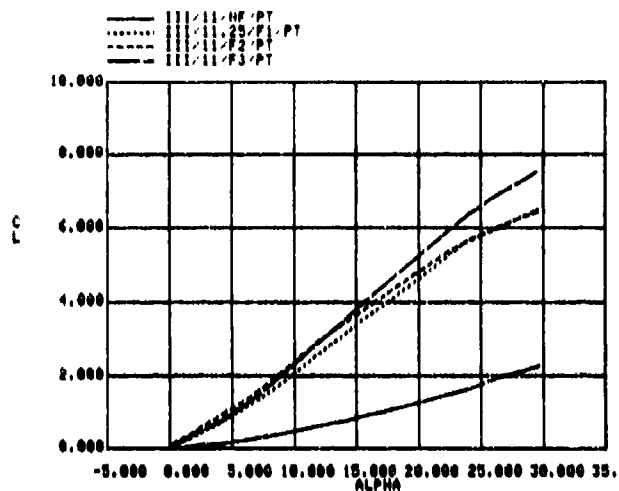


FIGURE A-29.1 FIN EFFECTS

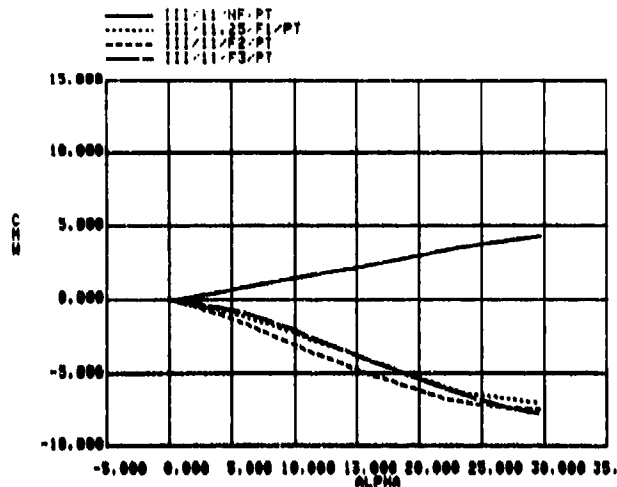


FIGURE A-29.4 FIN EFFECTS

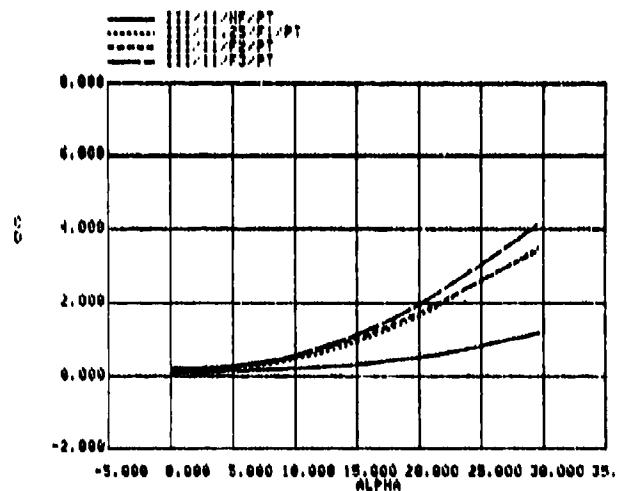


FIGURE A-29.2 FIN EFFECTS

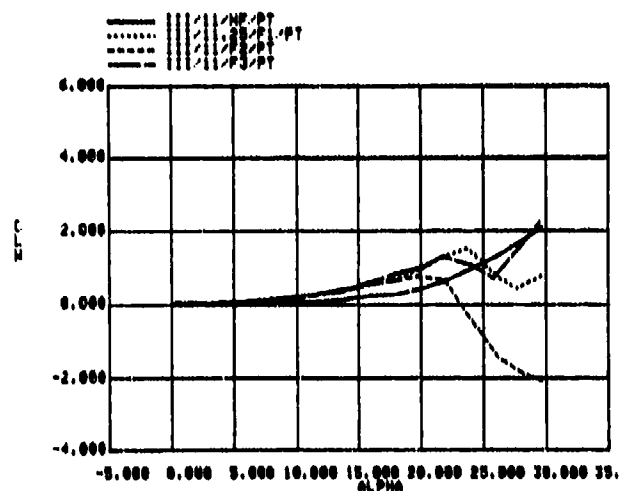


FIGURE A-29.5 FIN EFFECTS

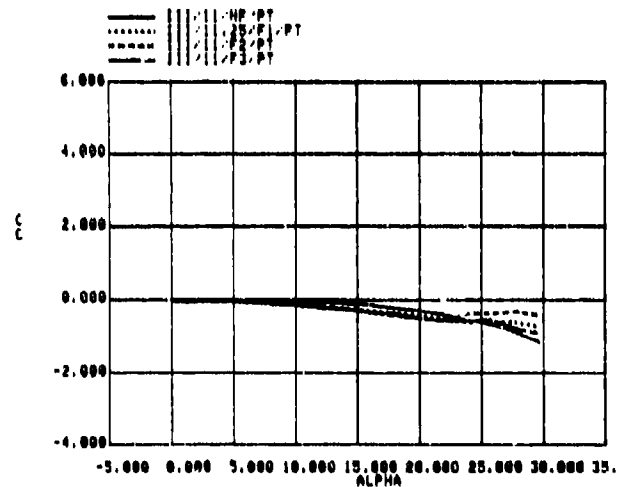


FIGURE A-29.3 FIN EFFECTS

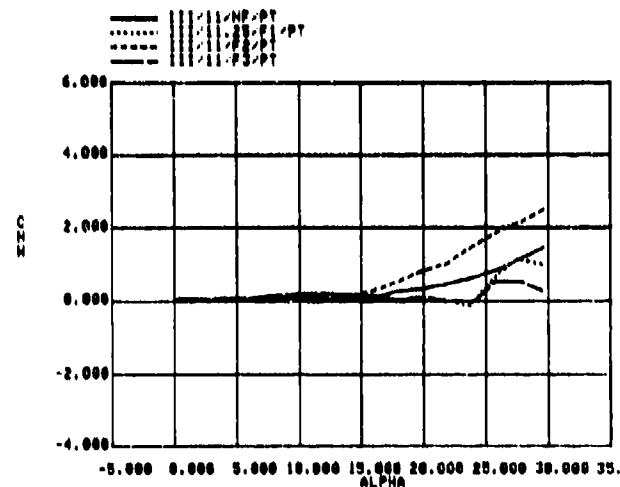


FIGURE A-29.6 FIN EFFECTS

FIGURE A-29. WIND AXIS FORCE & MOMENT FIN EFFECTS, MISSILE III.  
ROLL 11, POINTED NOSE.

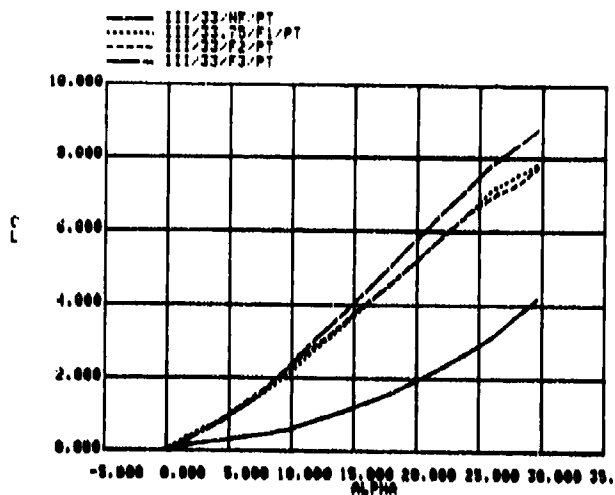


FIGURE A-30.1 FIN EFFECTS

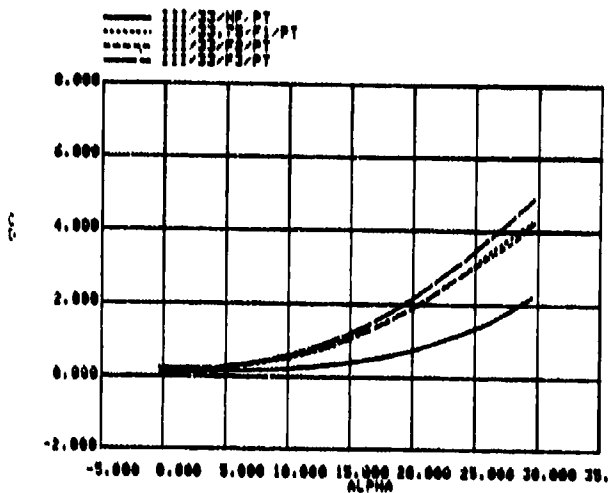


FIGURE A-30.2 FIN EFFECTS

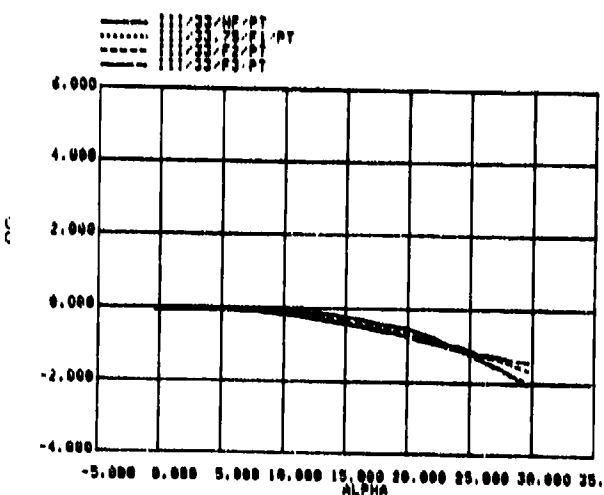


FIGURE A-30.3 FIN EFFECTS

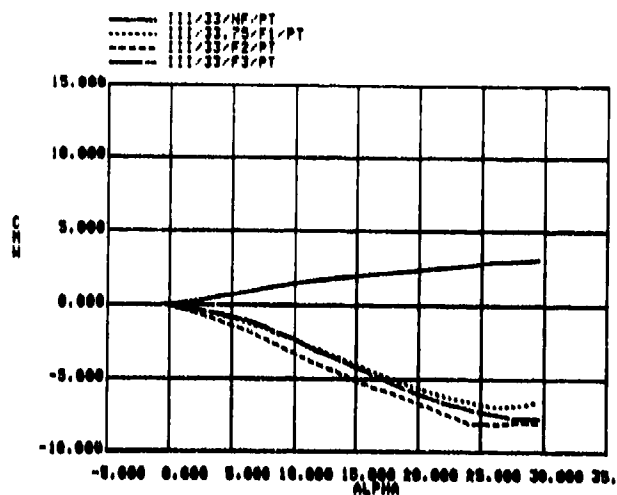


FIGURE A-30.4 FIN EFFECTS

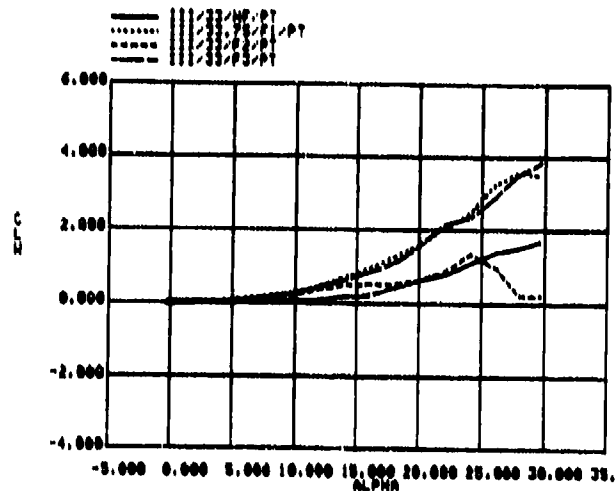


FIGURE A-30.5 FIN EFFECTS

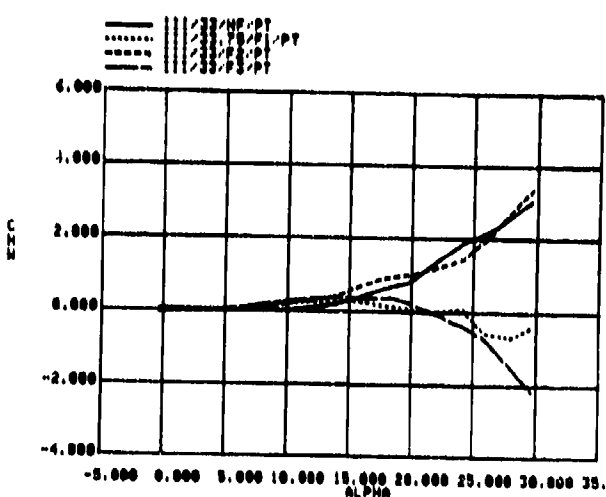


FIGURE A-30.6 FIN EFFECTS

FIGURE A-30. WIND AXIS FORCE & MOMENT FIN EFFECTS, MISSILE III.  
ROLL 33, POINTED NOSE.



## APPENDIX B

### TABULAR LISTING OF FORCE & MOMENT COEFFICIENTS

The force and moment tests conducted on the missiles of fineness ratio 8 are briefly described at the beginning of Appendix A. A total of 66 tests were conducted. Printouts of the coefficient data are illustrated in Figures B.1 through B.66. Figures B.1 through B.40 illustrate body axis data while figures B.41 through B.66 illustrate wind axis data. Table B-1 defines the nomenclature used in Figures B.1 - B.66. Tables B-2 and B-3 describe the missile configurations tested in each of the 66 tests.

TABLE B-1

APPENDIX B NOMENCLATURE

|       |   |
|-------|---|
| CA    | - Body Axis Axial Force Coefficient     |
| CC    | - Wind Axis Cross-Force Coefficient     |
| CD    | - Wind Axis Drag Coefficient            |
| CL    | - Wind Axis Lift Coefficient            |
| CLW   | - Wind Axis Rolling Moment Coefficient  |
| CM    | - Body Axis Pitching Moment Coefficient |
| CMW   | - Wind Axis Pitching Moment Coefficient |
| CN    | - Body Axis Normal Force Coefficient    |
| CNW   | - Wind Axis Yawing Moment Coefficient   |
| CY    | - Body Axis Side Force Coefficient      |
| ROLCO | - Body Axis Rolling Moment Coefficient  |
| YMCO  | - Body Axis Yawing Moment Coefficient   |

TABLE B-2

## FORCE - MOMENT TESTS

(DATA PRESENTED IN BODY AXIS SYSTEM FORMAT)

| <u>Body*</u> | <u>Roll</u> | <u>Fin**</u> | <u>Nose***</u> | <u>Appendix Figure</u> |
|--------------|-------------|--------------|----------------|------------------------|
| I            | 0°          | NF           | BL             | B-1                    |
| I            | 22°         | NF           | BL             | B-2                    |
| I            | 45°         | NF           | BL             | B-3                    |
| II           | 0°          | NF           | BL             | B-4                    |
| II           | 22°         | NF           | BL             | B-5                    |
| II           | 45°         | NF           | BL             | B-6                    |
| III          | 0°          | NF           | BL             | B-7                    |
| III          | 22°         | NF           | BL             | B-8                    |
| III          | 45°         | NF           | BL             | B-9                    |
| IV           | 0°          | NF           | BL             | B-10                   |
| III          | 0°          | NF           | PT             | B-11                   |
| III          | 22°         | NF           | PT             | B-12                   |
| III          | 45°         | NF           | PT             | B-13                   |
| I            | 0°          | F1           | BL             | B-14                   |
| I            | 22°         | F1           | BL             | B-15                   |
| I            | 45°         | F1           | BL             | B-16                   |
| II           | 0°          | F1           | BL             | B-17                   |
| II           | 22°         | F1           | BL             | B-18                   |
| II           | 45°         | F1           | BL             | B-19                   |
| III          | 0°          | F1           | BL             | B-20                   |
| III          | 22°         | F1           | BL             | B-21                   |
| III          | 45°         | F1           | BL             | B-22                   |
| IV           | 0°          | F1           | BL             | B-23                   |
| IV           | 22°         | F1           | BL             | B-24                   |
| IV           | 45°         | F1           | BL             | B-25                   |
| III          | 0°          | F1           | PT             | B-26                   |
| III          | 22°         | F1           | PT             | B-27                   |
| III          | 45°         | F1           | PT             | B-28                   |

TABLE B-2

## FORCE - MOMENT TESTS

(DATA PRESENTED IN BODY AXIS SYSTEM FORMAT)

| <u>Body*</u> | <u>Roll</u> | <u>Fin**</u> | <u>Nose***</u> | <u>Appendix Figure</u> |
|--------------|-------------|--------------|----------------|------------------------|
| III          | 0°          | F2           | BL             | B-29                   |
| III          | 22°         | F2           | BL             | B-30                   |
| III          | 45°         | F2           | BL             | B-31                   |
| III          | 0°          | F2           | PT             | B-32                   |
| III          | 22°         | F2           | PT             | B-33                   |
| III          | 45°         | F2           | PT             | B-34                   |
| III          | 0°          | F3           | BL             | B-35                   |
| III          | 22°         | F3           | BL             | B-36                   |
| III          | 45°         | F3           | BL             | B-37                   |
| III          | 0°          | F3           | PT             | B-38                   |
| III          | 22°         | F3           | PT             | B-39                   |
| III          | 45°         | F3           | PT             | B-40                   |

## \*Body Configurations

- I - Square
- II - 10% Corner Radius
- III - 20% Corner Radius
- IV - Round

## \*\*Fin Configurations

- NF - No Fins Attached
- F1 - Fin #1
- F2 - Fin #2
- F3 - Fin #3

## \*\*\*Nose Configurations

- BL - Blunt Nose
- PT - Pointed Nose

TABLE B-3

## FORCE - MOMENT TEST

(DATA PRESENTED IN WIND AXIS SYSTEM FORMAT)

| <u>Body*</u> | <u>Roll</u> | <u>Fin**</u> | <u>Nose***</u> | <u>Appendix Figure</u> |
|--------------|-------------|--------------|----------------|------------------------|
| I            | 11°         | NF           | BL             | B-41                   |
| I            | 33°         | NF           | BL             | B-42                   |
| II           | 11°         | NF           | BL             | B-43                   |
| II           | 33°         | NF           | BL             | B-44                   |
| III          | 11°         | NF           | BL             | B-45                   |
| III          | 33°         | NF           | BL             | B-46                   |
| III          | 11°         | NF           | PT             | B-47                   |
| III          | 33°         | NF           | PT             | B-48                   |
| I            | 11°         | F1           | BL             | B-49                   |
| I            | 33°         | F1           | BL             | B-50                   |
| II           | 11°         | F1           | BL             | B-51                   |
| II           | 33°         | F1           | BL             | B-52                   |
| III          | 11°         | F1           | BL             | B-53                   |
| III          | 33°         | F1           | BL             | B-54                   |
| IV           | 11°         | F1           | BL             | B-55                   |
| IV           | 33°         | F1           | BL             | B-56                   |
| III          | 11°         | F1           | PT             | B-57                   |
| III          | 33°         | F1           | PT             | B-58                   |
| III          | 11°         | F2           | BL             | B-59                   |
| III          | 33°         | F2           | BL             | B-60                   |
| III          | 11°         | F2           | PT             | B-61                   |
| III          | 33°         | F2           | PT             | B-62                   |
| III          | 11°         | F3           | BL             | B-63                   |
| III          | 33°         | F3           | BL             | B-64                   |
| III          | 11°         | F3           | PT             | B-65                   |
| III          | 33°         | F3           | PT             | B-66                   |

## \*Body Configurations

I - Square  
 II - 10% Corner Radius  
 III - 20% Corner Radius  
 IV - Round

## \*\*Fin Configurations

NF - No Fins Attached  
 F1 - Fin #1  
 F2 - Fin #2  
 F3 - Fin #3

## \*\*\*Nose Configurations

BL - Blunt Nose  
 PT - Pointed Nose

MISSILE I, ROLL 0, NO FINS, BLUNT NOSE - I/O/NF/BL

RUN NUMBER IS 7  
DATA TAKEN 13:03:59 06-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YNCO  | ROLCO  |
|----------------|-------|--------|--------|--------|-------|--------|
| 0.18           | 0.000 | 0.144  | -0.006 | -0.062 | 0.030 | -0.011 |
| 2.25           | 0.136 | 0.147  | -0.017 | 0.198  | 0.026 | -0.014 |
| 4.25           | 0.296 | 0.147  | -0.023 | 0.510  | 0.019 | -0.019 |
| 5.78           | 0.429 | 0.142  | -0.029 | 0.723  | 0.019 | -0.019 |
| 8.20           | 0.690 | 0.149  | -0.034 | 1.120  | 0.022 | -0.026 |
| 10.23          | 1.258 | 0.143  | -0.044 | 1.194  | 0.017 | -0.029 |
| 12.27          | 2.023 | 0.142  | -0.047 | 1.130  | 0.014 | -0.033 |
| 14.27          | 2.381 | 0.120  | -0.091 | 1.428  | 0.040 | -0.037 |
| 15.71          | 2.621 | 0.086  | -0.097 | 1.645  | 0.047 | -0.039 |
| 18.17          | 3.006 | 0.070  | -0.127 | 2.065  | 0.044 | -0.038 |
| 20.15          | 3.310 | 0.000  | -0.157 | 2.454  | 0.074 | -0.038 |
| 22.27          | 3.645 | -0.024 | -0.206 | 2.944  | 0.113 | -0.039 |
| 24.18          | 3.910 | -0.034 | -0.270 | 3.444  | 0.175 | -0.033 |
| 26.26          | 4.277 | -0.093 | -0.342 | 3.944  | 0.228 | -0.033 |
| 28.17          | 4.551 | -0.151 | -0.378 | 4.357  | 0.278 | -0.030 |
| 30.00          | 4.696 | -0.164 | -0.453 | 4.782  | 0.350 | -0.031 |

Figure B.1. Computer Tabulated Force and Moment Data for Missile I  
Zero Degrees Roll, No Fins, Blunt Nose

MISSILE I, ROLL 22.5, NO FINS, BLUNT NOS - I/22.5/NF/BI

RUN NUMBER IS 8  
DATA TAKEN 13:22:13 06-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YNCO   | ROLCO  |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.04          | 0.014 | 0.135  | -0.018 | -0.055 | 0.053  | -0.010 |
| 2.31           | 0.162 | 0.142  | -0.086 | 0.221  | -0.053 | -0.016 |
| 4.25           | 0.305 | 0.143  | -0.181 | 0.485  | -0.165 | -0.017 |
| 6.12           | 0.454 | 0.143  | -0.267 | 0.738  | -0.260 | -0.020 |
| 8.22           | 0.692 | 0.143  | -0.421 | 1.055  | -0.384 | -0.016 |
| 10.28          | 0.965 | 0.129  | -0.618 | 1.367  | -0.475 | -0.011 |
| 12.29          | 1.271 | 0.119  | -0.898 | 1.704  | -0.512 | -0.001 |
| 14.27          | 1.571 | 0.107  | -1.208 | 2.016  | -0.497 | 0.011  |
| 16.17          | 1.860 | 0.087  | -1.533 | 2.317  | -0.430 | 0.015  |
| 18.15          | 2.140 | 0.064  | -1.938 | 2.666  | -0.307 | 0.020  |
| 19.77          | 2.418 | 0.040  | -2.334 | 2.941  | -0.170 | 0.018  |
| 22.24          | 2.872 | 0.018  | -3.046 | 3.395  | 0.117  | 0.009  |
| 24.22          | 3.282 | -0.015 | -3.756 | 3.807  | 0.412  | -0.013 |
| 26.24          | 3.662 | -0.054 | -4.488 | 4.232  | 0.671  | -0.044 |
| 28.29          | 4.102 | -0.116 | -5.167 | 4.631  | 0.710  | -0.074 |
| 30.00          | 4.501 | -0.168 | -5.886 | 4.974  | 0.638  | -0.084 |

Figure B.2. Computer Tabulated Force and Moment Data for Missile I  
22° Roll, No Fins, Blunt Nose

MISSILE I, ROLL 45, NO FINS, BLUNT NOSE -- 1/45/NF/BL

RUN NUMBER IS 9  
DATA TAKEN 13:33:41 06-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMCN   | ROL CO |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.19          | 0.032 | 0.138  | -0.053 | -0.036 | 0.071  | -0.009 |
| 2.33           | 0.153 | 0.143  | -0.160 | 0.182  | -0.165 | -0.016 |
| 4.33           | 0.256 | 0.148  | -0.289 | 0.385  | -0.348 | -0.018 |
| 6.28           | 0.405 | 0.140  | -0.454 | 0.587  | -0.571 | -0.022 |
| 8.23           | 0.619 | 0.126  | -0.641 | 0.792  | -0.775 | -0.027 |
| 10.26          | 0.872 | 0.116  | -0.920 | 1.015  | -0.996 | -0.035 |
| 12.29          | 1.235 | 0.097  | -1.245 | 1.184  | -1.191 | -0.040 |
| 14.15          | 1.855 | 0.082  | -1.594 | 1.325  | -1.325 | -0.046 |
| 16.26          | 1.985 | 0.052  | -1.987 | 1.458  | -1.485 | -0.052 |
| 17.75          | 2.251 | 0.026  | -2.267 | 1.549  | -1.594 | -0.055 |
| 20.13          | 2.814 | -0.014 | -2.808 | 1.739  | -1.817 | -0.059 |
| 22.22          | 3.350 | -0.056 | -3.340 | 1.940  | -2.039 | -0.064 |
| 24.19          | 3.914 | -0.088 | -3.888 | 2.155  | -2.291 | -0.066 |
| 26.23          | 4.543 | -0.132 | -4.493 | 2.418  | -2.602 | -0.069 |
| 28.28          | 5.092 | -0.190 | -5.011 | 2.698  | -2.933 | -0.070 |
| 30.00          | 5.674 | -0.254 | -5.555 | 3.006  | -3.286 | -0.066 |

Figure B.3. Computer Tabulated Force and Moment Data for Missile I  
45° Roll, No Fins, Blunt Nose



MISSILE II, ROLL 0, NO FINS, BLUNT NOSE -- II/O/NF/BL

RUN NUMBER IS 1  
DATA TAKEN 09:53:17 06-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA      | CY     | CM     | YNCO    | ROL CO  |
|----------------|--------|---------|--------|--------|---------|---------|
| -0.01          | -0.044 | 0.148   | 0.016  | -0.125 | 0.007   | --0.011 |
| 2.34           | 0.109  | 0.152   | 0.018  | 0.184  | 0.003   | --0.015 |
| 4.40           | 0.247  | 0.152   | 0.009  | 0.477  | 0.002   | --0.016 |
| 6.27           | 0.362  | 0.156   | 0.006  | 0.762  | --0.006 | -0.021  |
| 8.20           | 0.530  | 0.146   | -0.015 | 1.029  | 0.001   | --0.023 |
| 10.28          | 0.844  | 0.145   | 0.046  | 1.234  | -0.039  | -0.029  |
| 12.29          | 1.219  | 0.141   | 0.112  | 1.439  | --0.116 | --0.026 |
| 14.28          | 1.543  | 0.115   | 0.118  | 1.689  | --0.148 | -0.026  |
| 15.71          | 1.723  | 0.089   | 0.117  | 1.897  | --0.153 | -0.023  |
| 17.82          | 1.995  | 0.071   | 0.111  | 2.207  | --0.157 | -0.024  |
| 19.72          | 2.331  | 0.021   | 0.134  | 2.428  | --0.181 | -0.023  |
| 22.25          | 2.771  | --0.023 | 0.100  | 2.708  | --0.180 | --0.027 |
| 24.23          | 3.186  | -0.081  | 0.088  | 2.926  | --0.186 | -0.026  |
| 26.28          | 3.552  | --0.105 | 0.061  | 3.225  | --0.157 | --0.019 |
| 28.20          | 3.891  | -0.146  | 0.049  | 3.457  | --0.144 | --0.015 |
| 30.00          | 4.271  | --0.204 | 0.007  | 3.734  | --0.128 | --0.006 |

Figure B.4. Computer Tabulated Force and Moment Data for Missile II  
0° Roll, No Fins, Blunt Nose

MISSILE II, ROLL 22.5, NO FINS, BLUNT NO - II/22.5/NF/BL

RUN NUMBER IS 2  
DATA TAKEN 10:31:39 06-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMCN   | ROLCO  |
|----------------|--------|--------|--------|--------|--------|--------|
| 0.03           | -0.023 | 0.150  | 0.021  | -0.092 | 0.058  | -0.010 |
| 2.39           | 0.103  | 0.154  | -0.023 | 0.191  | -0.060 | -0.015 |
| 4.27           | 0.205  | 0.144  | -0.077 | 0.424  | -0.149 | -0.020 |
| 6.20           | 0.327  | 0.145  | -0.153 | 0.682  | -0.246 | -0.024 |
| 8.21           | 0.451  | 0.150  | -0.266 | 0.967  | -0.341 | -0.028 |
| 10.21          | 0.705  | 0.143  | -0.428 | 1.256  | -0.421 | -0.028 |
| 12.30          | 0.941  | 0.132  | -0.652 | 1.545  | -0.442 | -0.023 |
| 13.98          | 1.157  | 0.123  | -0.874 | 1.811  | -0.413 | -0.024 |
| 16.29          | 1.426  | 0.106  | -1.238 | 2.162  | -0.306 | -0.028 |
| 17.71          | 1.593  | 0.082  | -1.472 | 2.364  | -0.198 | -0.029 |
| 19.76          | 1.860  | 0.062  | -1.908 | 2.721  | 0.041  | -0.040 |
| 22.27          | 2.241  | 0.041  | -2.629 | 3.158  | 0.430  | -0.060 |
| 24.24          | 2.538  | 0.014  | -3.262 | 3.474  | 0.795  | -0.084 |
| 26.29          | 2.878  | -0.019 | -4.011 | 3.843  | 1.110  | -0.112 |
| 27.76          | 3.147  | -0.047 | -4.537 | 4.087  | 1.297  | -0.129 |
| 30.00          | 3.610  | -0.111 | -5.299 | 4.377  | 1.363  | -0.150 |

Figure B.5. Computer Tabulated Force and Moment Data for Missile II  
22° Roll, No Fins, Blunt Nose

MISSILE II, ROLL 45, NO FINS, BLUNT NOSE - II/45/NF/BL

RUN NUMBER IS 3  
DATA TAKEN 10:49:12 06-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMCO   | ROLCO  |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.28          | 0.284 | 0.149  | 0.169  | -0.320 | -0.088 | -0.008 |
| 2.35           | 0.368 | 0.145  | 0.094  | -0.092 | -0.340 | -0.010 |
| 4.33           | 0.432 | 0.150  | -0.027 | 0.129  | -0.508 | -0.015 |
| 5.94           | 0.544 | 0.138  | -0.120 | 0.258  | -0.635 | -0.017 |
| 8.28           | 0.707 | 0.132  | -0.316 | 0.493  | -0.861 | -0.025 |
| 10.24          | 0.920 | 0.132  | -0.508 | 0.673  | -1.038 | -0.030 |
| 12.29          | 1.143 | 0.124  | -0.794 | 0.896  | -1.212 | -0.036 |
| 14.15          | 1.429 | 0.115  | -1.132 | 1.025  | -1.286 | -0.044 |
| 15.74          | 1.654 | 0.100  | -1.401 | 1.120  | -1.352 | -0.049 |
| 17.78          | 2.000 | 0.079  | -1.737 | 1.228  | -1.446 | -0.056 |
| 19.73          | 2.394 | 0.025  | -2.132 | 1.332  | -1.523 | -0.055 |
| 22.28          | 2.968 | -0.015 | -2.782 | 1.472  | -1.610 | -0.054 |
| 24.22          | 3.441 | -0.061 | -3.317 | 1.693  | -1.758 | -0.055 |
| 26.28          | 3.918 | -0.098 | -3.917 | 1.981  | -1.917 | -0.062 |
| 28.29          | 4.380 | -0.154 | -4.462 | 2.292  | -2.140 | -0.060 |
| 30.00          | 4.875 | -0.201 | -4.982 | 2.548  | -2.401 | -0.059 |

FIGURE B.6. Computer Tabulated Force and Moment Data for Missile II  
45° Roll, No Fins, Blunt Nose

MISSILE III, ROLL 0, NO FINS, BLUNT NOSE III/O/NF/BL

RUN NUMBER IS 4  
DATA TAKEN 11:27:47 06-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMCN  | ROL CN |
|----------------|-------|--------|--------|--------|-------|--------|
| -0.10          | 0.001 | 0.143  | 0.004  | -0.107 | 0.013 | -0.007 |
| 2.42           | 0.151 | 0.144  | -0.002 | 0.190  | 0.019 | -0.011 |
| 4.35           | 0.265 | 0.143  | -0.017 | 0.468  | 0.024 | -0.014 |
| 6.35           | 0.377 | 0.135  | -0.023 | 0.751  | 0.030 | -0.018 |
| 8.17           | 0.522 | 0.140  | -0.023 | 1.032  | 0.031 | -0.020 |
| 10.27          | 0.683 | 0.142  | -0.030 | 1.306  | 0.041 | -0.025 |
| 12.16          | 0.849 | 0.135  | -0.033 | 1.577  | 0.043 | -0.029 |
| 13.94          | 1.027 | 0.123  | -0.041 | 1.835  | 0.050 | -0.032 |
| 16.05          | 1.209 | 0.104  | -0.045 | 2.102  | 0.062 | -0.034 |
| 17.87          | 1.357 | 0.084  | -0.044 | 2.352  | 0.065 | -0.037 |
| 19.71          | 1.536 | 0.060  | -0.056 | 2.638  | 0.080 | -0.041 |
| 22.28          | 1.779 | 0.030  | -0.051 | 3.050  | 0.077 | -0.047 |
| 24.24          | 2.008 | 0.004  | -0.061 | 3.388  | 0.105 | -0.049 |
| 26.27          | 2.214 | -0.028 | -0.021 | 3.696  | 0.071 | -0.055 |
| 28.19          | 2.431 | -0.059 | -0.032 | 3.978  | 0.074 | -0.057 |
| 30.00          | 2.640 | -0.091 | -0.058 | 4.249  | 0.122 | -0.058 |

Figure B.7. Computer Tabulated Force and Moment Data for Missile III  
0° Roll, No Fins, Blunt Nose

RUN NUMBER IS 5  
DATA TAKEN 11:41:16 06-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMGD   | ROLCD  |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.01          | 0.138 | 0.123  | -0.062 | -0.019 | 0.031  | -0.002 |
| 2.45           | 0.259 | 0.140  | -0.124 | 0.270  | -0.089 | -0.007 |
| 4.38           | 0.360 | 0.139  | -0.167 | 0.522  | -0.179 | -0.010 |
| 6.32           | 0.447 | 0.135  | -0.228 | 0.752  | -0.263 | -0.015 |
| 8.26           | 0.558 | 0.139  | -0.278 | 1.006  | -0.352 | -0.020 |
| 9.90           | 0.668 | 0.134  | -0.337 | 1.211  | -0.416 | -0.027 |
| 12.30          | 0.878 | 0.131  | -0.474 | 1.499  | -0.489 | -0.032 |
| 13.71          | 0.995 | 0.118  | -0.572 | 1.671  | -0.489 | -0.036 |
| 16.30          | 1.211 | 0.091  | -0.793 | 1.956  | -0.443 | -0.043 |
| 17.74          | 1.324 | 0.075  | -0.933 | 2.126  | -0.388 | -0.046 |
| 19.90          | 1.500 | 0.060  | -1.186 | 2.424  | -0.249 | -0.054 |
| 22.25          | 1.717 | 0.037  | -1.527 | 2.804  | -0.021 | -0.064 |
| 24.23          | 1.866 | 0.018  | -1.963 | 3.196  | 0.335  | -0.074 |
| 26.26          | 2.039 | -0.005 | -2.480 | 3.523  | 0.824  | -0.086 |
| 28.28          | 2.260 | -0.041 | -2.987 | 3.756  | 1.297  | -0.104 |
| 30.00          | 2.470 | -0.077 | -3.495 | 3.987  | 1.677  | -0.117 |

Figure B.8. Computer Tabulated Force and Moment Data for Missile III  
22° Roll, No Fins, Blunt Nose

RUN NUMBER IS 6  
 DATA TAKEN 11:58:56 06-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YNCO   | ROLCO  |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.17          | 0.142 | 0.132  | -0.072 | -0.020 | 0.059  | -0.002 |
| 2.27           | 0.229 | 0.136  | -0.176 | 0.198  | -0.155 | -0.007 |
| 4.35           | 0.285 | 0.132  | -0.253 | 0.374  | -0.342 | -0.010 |
| 6.26           | 0.367 | 0.132  | -0.341 | 0.559  | -0.529 | -0.014 |
| 8.28           | 0.470 | 0.128  | -0.451 | 0.728  | -0.712 | -0.018 |
| 10.27          | 0.595 | 0.130  | -0.568 | 0.886  | -0.876 | -0.022 |
| 12.08          | 0.735 | 0.127  | -0.737 | 1.025  | -1.015 | -0.028 |
| 13.73          | 0.868 | 0.120  | -0.903 | 1.143  | -1.104 | -0.034 |
| 15.72          | 1.034 | 0.096  | -1.110 | 1.207  | -1.143 | -0.037 |
| 17.72          | 1.248 | 0.075  | -1.342 | 1.237  | -1.166 | -0.037 |
| 19.73          | 1.494 | 0.048  | -1.663 | 1.281  | -1.148 | -0.041 |
| 22.23          | 1.889 | 0.011  | -2.155 | 1.295  | -1.072 | -0.040 |
| 24.18          | 2.255 | -0.013 | -2.599 | 1.381  | -1.076 | -0.063 |
| 26.23          | 2.650 | -0.048 | -3.118 | 1.674  | -1.174 | -0.088 |
| 28.29          | 3.047 | -0.110 | -3.592 | 1.926  | -1.361 | -0.121 |
| 30.00          | 3.513 | -0.144 | -3.745 | 2.085  | -1.684 | -0.130 |

Figure B.9. Computer Tabulated Force and Moment Data for Missile III  
 45° Roll, No Fins, Blunt Nose

RUN NUMBER IS 12  
 DATA TAKEN 14:14:59 06-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA      | CY      | CM      | YMCO    | ROL CO  |
|----------------|-------|---------|---------|---------|---------|---------|
| -0.06          | 0.017 | 0.089   | --0.007 | --0.098 | 0.014   | --0.008 |
| 2.21           | 0.098 | 0.094   | --0.011 | 0.123   | 0.004   | --0.009 |
| 4.36           | 0.192 | 0.092   | --0.016 | 0.344   | 0.007   | --0.012 |
| 6.38           | 0.264 | 0.087   | --0.028 | 0.576   | 0.007   | --0.015 |
| 8.20           | 0.382 | 0.092   | --0.032 | 0.805   | 0.012   | --0.019 |
| 10.27          | 0.466 | 0.074   | --0.029 | 1.022   | 0.011   | --0.021 |
| 12.28          | 0.583 | 0.090   | --0.043 | 1.265   | 0.019   | --0.023 |
| 13.76          | 0.668 | 0.085   | --0.049 | 1.381   | 0.029   | --0.027 |
| 15.79          | 0.795 | 0.075   | --0.068 | 1.573   | 0.045   | --0.029 |
| 17.72          | 0.916 | 0.060   | --0.072 | 1.713   | 0.046   | --0.031 |
| 19.78          | 1.048 | 0.043   | --0.062 | 1.830   | 0.023   | --0.036 |
| 22.25          | 1.326 | 0.025   | --0.057 | 1.975   | 0.017   | --0.038 |
| 24.23          | 1.618 | 0.003   | 0.003   | 2.115   | --0.052 | --0.042 |
| 26.22          | 1.924 | --0.020 | 0.017   | 2.283   | --0.067 | --0.044 |
| 28.21          | 2.195 | --0.053 | 0.006   | 2.492   | --0.064 | --0.048 |
| 30.00          | 3.078 | --0.586 | --0.056 | 3.373   | --0.094 | --0.079 |

Figure B.10. Computer Tabulated Force and Moment Data for Missile IV  
 0° Roll No Fins, Blunt Nose

MISSILE III, ROLL 0, NO FINS, POINTED NO - III/O/NF/PT

RUN NUMBER IS 16  
DATA TAKEN 16102137 06-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YNCO   | ROLCO  |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.12          | 0.029 | 0.122  | 0.000  | -0.097 | 0.018  | -0.006 |
| 2.20           | 0.156 | 0.123  | -0.014 | 0.214  | 0.016  | -0.010 |
| 4.40           | 0.273 | 0.119  | -0.023 | 0.504  | 0.019  | -0.013 |
| 6.27           | 0.388 | 0.113  | -0.032 | 0.788  | 0.020  | -0.016 |
| 8.27           | 0.540 | 0.116  | -0.023 | 1.090  | 0.021  | -0.020 |
| 10.27          | 0.685 | 0.112  | -0.028 | 1.402  | 0.019  | -0.024 |
| 12.27          | 0.856 | 0.101  | -0.034 | 1.699  | 0.017  | -0.027 |
| 14.27          | 1.051 | 0.099  | -0.039 | 2.000  | 0.031  | -0.033 |
| 16.28          | 1.242 | 0.085  | -0.042 | 2.303  | 0.030  | -0.034 |
| 17.74          | 1.378 | 0.066  | -0.018 | 2.491  | 0.018  | -0.037 |
| 19.84          | 1.582 | 0.043  | -0.035 | 2.859  | 0.030  | -0.042 |
| 22.24          | 1.881 | 0.017  | 0.013  | 3.263  | -0.001 | -0.047 |
| 24.21          | 2.095 | -0.009 | 0.060  | 3.604  | -0.029 | -0.050 |
| 26.22          | 2.332 | -0.037 | -0.033 | 3.960  | 0.058  | -0.054 |
| 28.29          | 2.583 | -0.077 | -0.087 | 4.275  | 0.131  | -0.058 |
| 30.00          | 2.788 | -0.104 | -0.154 | 4.560  | 0.220  | -0.059 |

Figure B.11. Computer Tabulated Force and Moment Data for Missile III  
0° Roll, No Fins, Pointed Nose



MISSILE III, ROLL 22.5, NO FINS, POINTED - III/22.5/NF/PT

RUN NUMBER IS 17  
DATA TAKEN 16:14:41 06-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM    | YMCN   | ROI CO |
|----------------|-------|--------|--------|-------|--------|--------|
| 0.22           | 0.126 | 0.117  | -0.053 | 0.009 | 0.012  | -0.006 |
| 2.22           | 0.222 | 0.127  | -0.115 | 0.262 | -0.091 | -0.009 |
| 4.36           | 0.321 | 0.122  | -0.164 | 0.537 | -0.174 | -0.013 |
| 6.33           | 0.419 | 0.109  | -0.207 | 0.786 | -0.290 | -0.017 |
| 8.30           | 0.562 | 0.103  | -0.273 | 1.060 | -0.396 | -0.021 |
| 10.28          | 0.703 | 0.108  | -0.343 | 1.325 | -0.481 | -0.028 |
| 12.29          | 0.878 | 0.102  | -0.420 | 1.596 | -0.551 | -0.034 |
| 13.81          | 1.007 | 0.098  | -0.596 | 1.807 | -0.584 | -0.035 |
| 16.09          | 1.222 | 0.078  | -0.790 | 2.049 | -0.553 | -0.034 |
| 17.72          | 1.384 | 0.061  | -0.956 | 2.250 | -0.492 | -0.031 |
| 20.25          | 1.602 | 0.041  | -1.285 | 2.730 | -0.364 | -0.062 |
| 22.24          | 1.812 | 0.029  | -1.697 | 3.103 | -0.098 | -0.085 |
| 24.18          | 2.094 | 0.015  | -1.969 | 3.354 | 0.075  | -0.101 |
| 26.22          | 2.360 | -0.016 | -2.440 | 3.728 | 0.355  | -0.122 |
| 28.29          | 2.681 | -0.054 | -2.763 | 4.026 | 0.509  | -0.131 |
| 30.00          | 3.049 | -0.104 | -3.485 | 4.248 | 1.052  | -0.159 |

Figure B.12. Computer Tabulated Force and Moment Data for Missile III  
22° Roll, No Fins, Pointed Nose

MISSILE III, ROLL 45, NO FINS, POINTED N - III/45/NF/PT

RUN NUMBER IS 20  
DATA TAKEN 16:26:41 06-NAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM    | YMC0   | ROLCO  |
|----------------|-------|--------|--------|-------|--------|--------|
| -0.26          | 0.084 | 0.142  | -0.087 | 0.003 | 0.029  | -0.005 |
| 2.34           | 0.173 | 0.141  | -0.195 | 0.213 | -0.186 | -0.009 |
| 3.80           | 0.239 | 0.143  | -0.262 | 0.359 | -0.330 | -0.012 |
| 6.33           | 0.320 | 0.133  | -0.363 | 0.618 | -0.586 | -0.017 |
| 8.29           | 0.432 | 0.133  | -0.484 | 0.814 | -0.776 | -0.022 |
| 10.27          | 0.540 | 0.130  | -0.606 | 1.004 | -0.959 | -0.029 |
| 12.28          | 0.737 | 0.126  | -0.793 | 1.155 | -1.117 | -0.038 |
| 14.26          | 0.941 | 0.110  | -1.000 | 1.292 | -1.239 | -0.045 |
| 16.28          | 1.173 | 0.089  | -1.269 | 1.406 | -1.317 | -0.050 |
| 17.75          | 1.352 | 0.068  | -1.462 | 1.474 | -1.365 | -0.053 |
| 20.29          | 1.755 | 0.046  | -1.909 | 1.601 | -1.459 | -0.056 |
| 22.23          | 2.126 | 0.023  | -2.213 | 1.725 | -1.630 | -0.051 |
| 24.17          | 2.518 | 0.000  | -2.576 | 1.950 | -1.915 | -0.050 |
| 26.21          | 2.968 | -0.029 | -3.013 | 2.096 | -2.125 | -0.052 |
| 28.27          | 3.377 | -0.077 | -3.485 | 2.391 | -2.348 | -0.063 |
| 30.00          | 3.811 | -0.132 | -3.932 | 2.720 | -2.688 | -0.066 |

Figure B.13. Computer Tabulated Force and Moment Data for Missile III  
45° Roll, No Fins, Pointed Nose

RUN NUMBER IS 27  
DATA TAKEN 15:34:12 07-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMC0   | ROL CO |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.14          | -0.054 | 0.261  | 0.025  | 0.061  | -0.016 | -0.010 |
| 2.21           | 0.188  | 0.243  | -0.107 | -0.070 | 0.105  | -0.011 |
| 4.36           | 0.432  | 0.237  | -0.235 | -0.212 | 0.233  | -0.018 |
| 6.35           | 0.706  | 0.232  | -0.356 | -0.373 | 0.338  | -0.023 |
| 8.16           | 1.165  | 0.220  | -0.367 | -0.677 | 0.334  | -0.023 |
| 10.30          | 1.800  | 0.201  | -0.377 | -1.128 | 0.333  | -0.024 |
| 12.23          | 2.465  | 0.182  | -0.383 | -1.637 | 0.338  | -0.024 |
| 14.28          | 3.116  | 0.143  | -0.389 | -2.113 | 0.321  | -0.018 |
| 16.19          | 3.685  | 0.109  | -0.422 | -2.529 | 0.328  | -0.019 |
| 18.01          | 4.313  | 0.069  | -0.436 | -2.954 | 0.313  | -0.002 |
| 19.91          | 4.910  | 0.021  | -0.443 | -3.414 | 0.300  | 0.011  |
| 22.26          | 5.790  | -0.034 | -0.487 | -4.002 | 0.294  | 0.030  |
| 24.21          | 6.470  | -0.072 | -0.524 | -4.445 | 0.291  | 0.062  |
| 26.26          | 7.195  | -0.121 | -0.551 | -4.880 | 0.264  | 0.100  |
| 28.23          | 7.763  | -0.151 | -0.649 | -5.025 | 0.331  | 0.162  |
| 30.00          | 8.196  | -0.175 | -0.598 | -4.880 | 0.247  | 0.143  |

Figure B.14. Computer Tabulated Force and Moment Data for Missile I  
0° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 30  
DATA TAKEN 15:48:52 07-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMOO   | ROICO  |
|----------------|--------|--------|--------|--------|--------|--------|
| 0.44           | -0.358 | 0.247  | -0.036 | 0.564  | -0.051 | -0.006 |
| 2.40           | -0.070 | 0.232  | -0.125 | 0.328  | 0.092  | -0.009 |
| 4.25           | 0.300  | 0.235  | -0.401 | 0.036  | 0.234  | -0.014 |
| 6.35           | 0.624  | 0.221  | -0.606 | -0.234 | 0.397  | -0.011 |
| 8.26           | 1.208  | 0.212  | -0.781 | -0.645 | 0.492  | -0.006 |
| 10.26          | 1.628  | 0.126  | -1.247 | -0.916 | 0.868  | 0.014  |
| 12.23          | 2.272  | 0.177  | -1.644 | -1.352 | 1.112  | 0.049  |
| 13.73          | 2.716  | 0.157  | -1.937 | -1.665 | 1.300  | 0.081  |
| 16.34          | 3.529  | 0.118  | -2.499 | -2.203 | 1.630  | 0.165  |
| 17.77          | 3.982  | 0.101  | -2.841 | -2.505 | 1.808  | 0.234  |
| 19.77          | 4.627  | 0.056  | -3.369 | -2.874 | 2.053  | 0.362  |
| 22.25          | 5.509  | 0.012  | -4.120 | -3.302 | 2.318  | 0.526  |
| 24.21          | 6.164  | -0.026 | -4.811 | -3.630 | 2.593  | 0.668  |
| 26.26          | 6.868  | -0.076 | -5.666 | -3.792 | 2.874  | 0.774  |
| 27.75          | 7.381  | -0.104 | -6.233 | -3.873 | 2.970  | 0.792  |
| 30.00          | 7.206  | -0.117 | -7.161 | -3.362 | 2.928  | 0.581  |

Figure B.15. Computer Tabulated Force and Moment Data for Missile I  
22° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 31  
DATA TAKEN 16:00:03 07-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMCD   | ROLCO  |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.00          | -0.642 | 0.258  | 0.087  | 0.750  | -0.283 | -0.010 |
| 2.27           | -0.309 | 0.253  | -0.218 | 0.514  | -0.006 | -0.015 |
| 4.35           | -0.005 | 0.238  | -0.525 | 0.262  | 0.244  | -0.023 |
| 6.29           | 0.364  | 0.231  | -0.887 | -0.004 | 0.521  | -0.030 |
| 8.22           | 0.759  | 0.203  | -1.209 | -0.311 | 0.760  | -0.039 |
| 10.27          | 1.250  | 0.179  | -1.791 | -0.663 | 1.167  | -0.039 |
| 12.24          | 1.822  | 0.174  | -2.364 | -1.013 | 1.544  | -0.052 |
| 13.72          | 2.236  | 0.155  | -2.788 | -1.273 | 1.802  | -0.060 |
| 16.27          | 2.950  | 0.126  | -3.505 | -1.713 | 2.222  | -0.084 |
| 17.71          | 3.368  | 0.095  | -3.927 | -1.927 | 2.444  | -0.102 |
| 20.27          | 4.292  | 0.052  | -4.834 | -2.413 | 2.930  | -0.114 |
| 22.26          | 4.994  | 0.012  | -5.547 | -2.710 | 3.207  | -0.127 |
| 24.21          | 5.773  | -0.025 | -6.302 | -2.945 | 3.422  | -0.132 |
| 26.25          | 6.555  | -0.082 | -7.123 | -3.056 | 3.517  | -0.130 |
| 28.29          | 7.316  | -0.142 | -7.854 | -3.144 | 3.602  | -0.126 |
| 30.00          | 8.038  | -0.209 | -8.557 | -3.210 | 3.607  | -0.122 |

Figure B.16. Computer Tabulated Force and Moment Data for Missile I  
45° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 21  
DATA TAKEN 13:13:29 07-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMCN  | ROL CO |
|----------------|--------|--------|--------|--------|-------|--------|
| -0.03          | -0.085 | 0.229  | 0.004  | 0.081  | 0.004 | -0.022 |
| 2.28           | 0.174  | 0.230  | -0.135 | -0.092 | 0.132 | -0.027 |
| 4.31           | 0.403  | 0.212  | -0.251 | -0.284 | 0.244 | -0.032 |
| 6.20           | 0.678  | 0.203  | -0.358 | -0.525 | 0.339 | -0.039 |
| 8.09           | 1.121  | 0.192  | -0.359 | -0.962 | 0.326 | -0.038 |
| 10.11          | 1.669  | 0.173  | -0.358 | -1.484 | 0.322 | -0.031 |
| 12.22          | 2.292  | 0.150  | -0.411 | -2.087 | 0.287 | -0.014 |
| 13.72          | 2.724  | 0.131  | -0.427 | -2.461 | 0.290 | -0.005 |
| 16.21          | 3.394  | 0.089  | -0.454 | -3.108 | 0.294 | 0.024  |
| 18.03          | 3.931  | 0.036  | -0.489 | -3.586 | 0.281 | 0.041  |
| 20.29          | 4.639  | 0.014  | -0.506 | -4.182 | 0.216 | 0.055  |
| 22.26          | 5.269  | -0.017 | -0.525 | -4.715 | 0.239 | 0.078  |
| 24.24          | 5.892  | -0.052 | -0.583 | -5.155 | 0.274 | 0.114  |
| 26.27          | 6.428  | -0.078 | -0.635 | -5.401 | 0.214 | 0.167  |
| 28.01          | 6.821  | -0.110 | -0.651 | -5.417 | 0.109 | 0.194  |
| 30.00          | 7.270  | -0.138 | -0.682 | -5.247 | 0.103 | 0.224  |

Figure 17. Computer Tabulated Force and Moment Data for Missile II  
0° Roll, Fin No. 1, Blunt Nose

MISSILE II: ROLL 22.5, FIN 1, BLUNT NOSE - II/22.5/F1/BL

RUN NUMBER IS 22  
DATA TAKEN 13:37:50 07-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YNCO   | ROI CO |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.31          | -0.121 | 0.258  | 0.071  | 0.086  | -0.041 | -0.017 |
| 2.37           | 0.307  | 0.248  | -0.116 | -0.258 | 0.116  | -0.022 |
| 4.26           | 0.674  | 0.238  | -0.285 | -0.572 | 0.270  | -0.029 |
| 6.17           | 1.035  | 0.223  | -0.471 | -0.913 | 0.459  | -0.033 |
| 8.21           | 1.459  | 0.210  | -0.607 | -1.320 | 0.620  | -0.030 |
| 10.21          | 1.982  | 0.190  | -0.989 | -1.830 | 0.964  | -0.016 |
| 12.30          | 2.551  | 0.168  | -1.357 | -2.354 | 1.287  | 0.015  |
| 14.19          | 3.081  | 0.145  | -1.675 | -2.841 | 1.549  | 0.047  |
| 15.88          | 3.530  | 0.118  | -2.004 | -3.228 | 1.784  | 0.131  |
| 17.96          | 4.056  | 0.083  | -2.405 | -3.685 | 2.016  | 0.230  |
| 19.76          | 4.614  | 0.054  | -2.796 | -4.110 | 2.270  | 0.345  |
| 22.27          | 5.332  | 0.015  | -3.402 | -4.543 | 2.572  | 0.518  |
| 24.23          | 5.971  | -0.018 | -3.962 | -4.889 | 2.664  | 0.635  |
| 26.28          | 6.466  | -0.064 | -4.578 | -4.961 | 2.666  | 0.684  |
| 28.08          | 6.800  | -0.129 | -5.089 | -4.962 | 2.661  | 0.724  |
| 30.00          | 7.146  | -0.144 | -5.608 | -4.642 | 2.332  | 0.566  |

Figure B.18. Computer Tabulated Force and Moment Data for Missile II  
22° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 23  
DATA TAKEN 13157108 07-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YNCO  | ROLCO  |
|----------------|--------|--------|--------|--------|-------|--------|
| 0.29           | -0.016 | 0.271  | 0.040  | 0.002  | 0.016 | -0.021 |
| 2.34           | 0.237  | 0.256  | -0.222 | -0.213 | 0.234 | -0.024 |
| 4.46           | 0.523  | 0.241  | -0.504 | -0.485 | 0.501 | -0.034 |
| 6.37           | 0.846  | 0.231  | -0.831 | -0.807 | 0.810 | -0.040 |
| 8.28           | 1.154  | 0.219  | -0.919 | -1.103 | 0.921 | -0.044 |
| 10.29          | 1.598  | 0.205  | -1.123 | -1.559 | 1.117 | -0.048 |
| 12.19          | 2.063  | 0.184  | -1.345 | -1.946 | 1.268 | -0.055 |
| 14.22          | 2.505  | 0.121  | -1.598 | -2.310 | 1.416 | -0.060 |
| 15.81          | 2.898  | 0.130  | -1.782 | -2.551 | 1.482 | -0.073 |
| 17.78          | 3.339  | 0.046  | -2.032 | -2.848 | 1.564 | -0.072 |
| 20.24          | 4.061  | -0.041 | -2.425 | -3.236 | 1.662 | -0.098 |
| 22.26          | 4.684  | -0.133 | -2.808 | -3.552 | 1.702 | -0.112 |
| 24.23          | 5.422  | -0.198 | -3.276 | -3.842 | 1.736 | -0.109 |
| 26.26          | 6.104  | -0.244 | -3.687 | -4.065 | 1.700 | -0.128 |
| 27.88          | 6.560  | -0.248 | -3.967 | -4.132 | 1.617 | -0.135 |
| 30.00          | 7.303  | -0.442 | -4.412 | -4.125 | 1.385 | -0.142 |

Figure B.19. Computer Tabulated Force and Moment Data for Missile II  
45° Roll, Fin No. 1, Blunt Nose



RUN NUMBER IS 24  
DATA TAKEN 14:31:33 07-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMCO  | ROLCO  |
|----------------|-------|--------|--------|--------|-------|--------|
| 0.50           | 0.028 | 0.242  | -0.002 | -0.009 | 0.007 | -0.014 |
| 2.28           | 0.361 | 0.236  | -0.013 | -0.291 | 0.014 | -0.017 |
| 4.39           | 0.705 | 0.214  | -0.003 | -0.606 | 0.018 | -0.024 |
| 5.88           | 1.035 | 0.206  | -0.020 | -0.879 | 0.027 | -0.026 |
| 8.27           | 1.551 | 0.185  | -0.009 | -1.454 | 0.033 | -0.027 |
| 10.26          | 2.046 | 0.171  | -0.024 | -2.022 | 0.042 | -0.030 |
| 12.31          | 2.644 | 0.153  | -0.037 | -2.696 | 0.044 | -0.035 |
| 13.69          | 3.011 | 0.133  | -0.050 | -3.107 | 0.052 | -0.031 |
| 16.23          | 3.643 | 0.094  | -0.075 | -3.821 | 0.058 | -0.037 |
| 18.09          | 4.112 | 0.056  | -0.076 | -4.358 | 0.066 | -0.044 |
| 20.14          | 4.711 | 0.019  | -0.073 | -4.992 | 0.072 | -0.041 |
| 22.25          | 5.305 | -0.023 | -0.103 | -5.649 | 0.075 | -0.040 |
| 24.23          | 5.902 | -0.060 | -0.095 | -6.279 | 0.087 | -0.037 |
| 26.29          | 6.462 | -0.096 | -0.082 | -6.859 | 0.102 | -0.049 |
| 28.29          | 6.935 | -0.120 | -0.092 | -7.169 | 0.089 | -0.047 |
| 30.00          | 7.180 | -0.111 | -0.107 | -6.931 | 0.071 | -0.019 |

Figure B.20. Computer Tabulated Force and Moment Data for Missile III  
0° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 25  
DATA TAKEN 14144134 07-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMC0   | ROLCO  |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.16          | 0.047 | 0.251  | -0.011 | 0.133  | -0.054 | -0.007 |
| 2.06           | 0.386 | 0.248  | -0.158 | -0.179 | 0.069  | -0.011 |
| 4.32           | 0.774 | 0.234  | -0.322 | -0.524 | 0.237  | -0.021 |
| 6.44           | 1.156 | 0.217  | -0.495 | -0.910 | 0.438  | -0.027 |
| 8.29           | 1.534 | 0.202  | -0.676 | -1.311 | 0.671  | -0.031 |
| 10.10          | 1.939 | 0.187  | -0.912 | -1.801 | 0.975  | -0.036 |
| 11.96          | 2.425 | 0.166  | -1.179 | -2.369 | 1.320  | -0.040 |
| 13.73          | 2.860 | 0.140  | -1.452 | -2.904 | 1.650  | -0.020 |
| 15.71          | 3.331 | 0.106  | -1.718 | -3.450 | 1.937  | -0.002 |
| 18.13          | 3.930 | 0.071  | -2.086 | -4.156 | 2.328  | 0.044  |
| 20.23          | 4.510 | 0.028  | -2.442 | -4.725 | 2.674  | 0.085  |
| 22.27          | 5.067 | 0.010  | -2.851 | -5.227 | 3.023  | 0.149  |
| 24.22          | 5.501 | -0.001 | -3.243 | -5.472 | 3.191  | 0.192  |
| 26.26          | 5.946 | 0.000  | -3.564 | -5.562 | 3.182  | 0.149  |
| 27.90          | 6.286 | -0.032 | -3.838 | -5.714 | 3.276  | 0.112  |
| 30.00          | 6.725 | -0.049 | -4.472 | -5.706 | 3.647  | 0.071  |

Figure B.21. Computer Tabulated Force and Moment Data for Missile III  
22° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 26  
DATA TAKEN 14:57:04 07-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMCO   | ROLCO  |
|----------------|-------|--------|--------|--------|--------|--------|
| 0.01           | 0.049 | 0.250  | -0.047 | 0.102  | -0.126 | -0.004 |
| 2.27           | 0.353 | 0.244  | -0.334 | -0.146 | 0.127  | -0.013 |
| 4.41           | 0.606 | 0.238  | -0.608 | -0.395 | 0.390  | -0.021 |
| 6.39           | 0.891 | 0.222  | -0.890 | -0.693 | 0.694  | -0.024 |
| 8.23           | 1.212 | 0.215  | -1.233 | -1.055 | 1.086  | -0.028 |
| 9.79           | 1.506 | 0.205  | -1.532 | -1.432 | 1.446  | -0.031 |
| 12.00          | 1.996 | 0.187  | -2.017 | -2.075 | 2.089  | -0.034 |
| 13.75          | 2.386 | 0.160  | -2.451 | -2.580 | 2.599  | -0.029 |
| 16.29          | 2.906 | 0.117  | -3.020 | -3.271 | 3.307  | -0.013 |
| 18.10          | 3.343 | 0.097  | -3.466 | -3.748 | 3.796  | -0.009 |
| 20.29          | 3.877 | 0.074  | -4.024 | -4.343 | 4.346  | 0.003  |
| 22.23          | 4.418 | 0.054  | -4.584 | -4.906 | 4.883  | 0.009  |
| 24.21          | 4.989 | 0.038  | -5.152 | -5.409 | 5.298  | 0.023  |
| 26.26          | 5.590 | -0.004 | -5.746 | -5.729 | 5.834  | 0.038  |
| 28.29          | 6.228 | -0.053 | -6.670 | -6.845 | 6.218  | -0.006 |
| 30.00          | 6.891 | -0.087 | -7.293 | -6.096 | 6.430  | -0.041 |

Figure B.22. Computer Tabulated Force and Moment Data for Missile III  
45° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 32  
DATA TAKEN 09:33:02 10-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA      | CY      | CM      | YMCO    | ROL CO  |
|----------------|--------|---------|---------|---------|---------|---------|
| -0.04          | -0.080 | 0.203   | --0.005 | 0.031   | 0.006   | --0.011 |
| 2.22           | 0.278  | 0.202   | 0.004   | --0.292 | 0.002   | --0.014 |
| 4.30           | 0.571  | 0.189   | 0.008   | --0.621 | 0.007   | --0.017 |
| 6.44           | 0.894  | 0.173   | --0.003 | --1.070 | 0.008   | --0.020 |
| 8.35           | 1.233  | 0.158   | --0.006 | --1.478 | 0.012   | --0.021 |
| 10.29          | 1.697  | 0.150   | --0.014 | --2.034 | 0.025   | --0.024 |
| 12.26          | 2.131  | 0.129   | --0.024 | --2.664 | 0.052   | --0.027 |
| 13.95          | 2.530  | 0.114   | --0.048 | --3.227 | 0.088   | -0.027  |
| 16.33          | 3.059  | 0.087   | --0.049 | --4.028 | 0.103   | --0.019 |
| 17.95          | 3.380  | 0.061   | --0.034 | --4.465 | 0.055   | --0.032 |
| 19.76          | 3.825  | 0.033   | --0.043 | --5.083 | 0.074   | --0.028 |
| 22.28          | 4.467  | 0.006   | --0.066 | --5.976 | 0.060   | --0.003 |
| 24.25          | 5.001  | --0.018 | --0.081 | --6.668 | 0.059   | 0.018   |
| 26.06          | 5.462  | --0.030 | --0.088 | --7.149 | 0.041   | 0.052   |
| 27.76          | 5.835  | --0.055 | --0.160 | --7.422 | 0.063   | 0.087   |
| 30.00          | 6.252  | --0.084 | --0.130 | --7.438 | --0.036 | 0.101   |

Figure B.23. Computer Tabulated Force and Moment Data for Missile IV  
0° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 33  
DATA TAKEN 09:44:28 10-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMCO   | ROLCO  |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.22          | 0.037 | 0.180  | -0.011 | 0.138  | -0.066 | -0.006 |
| 2.25           | 0.347 | 0.186  | -0.132 | -0.218 | 0.080  | -0.010 |
| 4.31           | 0.659 | 0.169  | -0.281 | -0.490 | 0.219  | -0.016 |
| 6.30           | 0.955 | 0.152  | -0.422 | -0.856 | 0.405  | -0.019 |
| 8.29           | 1.263 | 0.140  | -0.565 | -1.318 | 0.646  | -0.023 |
| 10.27          | 1.667 | 0.127  | -0.773 | -1.848 | 0.965  | -0.024 |
| 12.30          | 2.146 | 0.111  | -1.026 | -2.464 | 1.293  | -0.033 |
| 13.88          | 2.441 | 0.091  | -1.181 | -2.958 | 1.563  | -0.051 |
| 15.80          | 2.826 | 0.066  | -1.380 | -3.505 | 1.893  | -0.071 |
| 18.35          | 3.367 | 0.028  | -1.667 | -4.310 | 2.352  | -0.087 |
| 20.26          | 3.842 | 0.002  | -1.924 | -4.976 | 2.717  | -0.088 |
| 22.23          | 4.328 | -0.017 | -2.187 | -5.624 | 3.096  | -0.077 |
| 24.21          | 4.780 | -0.034 | -2.427 | -6.174 | 3.429  | -0.105 |
| 26.26          | 5.071 | -0.003 | -2.402 | -6.070 | 3.286  | -0.153 |
| 28.08          | 5.473 | -0.035 | -2.600 | -6.482 | 3.547  | -0.549 |
| 30.00          | 5.936 | -0.077 | -2.794 | -6.808 | 3.784  | -0.624 |

Figure No. B.24. Computer Tabulated Force and Moment Data for Missile IV  
22° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 34  
DATA TAKEN 09:53:44 10-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMCD  | ROL CD |
|----------------|-------|--------|--------|--------|-------|--------|
| -0.23          | 0.057 | 0.192  | -0.037 | 0.088  | 0.131 | -0.011 |
| 2.35           | 0.300 | 0.183  | -0.280 | -0.158 | 0.120 | -0.013 |
| 4.13           | 0.503 | 0.174  | -0.488 | -0.358 | 0.330 | -0.020 |
| 6.26           | 0.777 | 0.164  | -0.764 | -0.692 | 0.674 | -0.027 |
| 8.22           | 1.023 | 0.151  | -1.017 | -1.032 | 1.020 | -0.030 |
| 10.25          | 1.344 | 0.139  | -1.358 | -1.505 | 1.498 | -0.032 |
| 12.01          | 1.686 | 0.124  | -1.686 | -1.966 | 1.964 | -0.047 |
| 13.96          | 2.037 | 0.104  | -2.031 | -2.557 | 2.518 | -0.051 |
| 15.75          | 2.363 | 0.075  | -2.366 | -3.077 | 3.026 | -0.044 |
| 18.35          | 2.806 | 0.042  | -2.816 | -3.731 | 3.697 | -0.030 |
| 20.23          | 3.143 | 0.018  | -3.191 | -4.211 | 4.207 | -0.026 |
| 22.25          | 3.552 | -0.005 | -3.651 | -4.771 | 4.827 | -0.018 |
| 24.23          | 3.898 | -0.018 | -4.033 | -5.222 | 5.322 | -0.007 |
| 26.26          | 4.259 | -0.030 | -4.415 | -5.646 | 5.716 | 0.002  |
| 27.98          | 4.498 | -0.036 | -4.695 | -5.711 | 5.813 | -0.066 |
| 30.00          | 4.767 | -0.045 | -5.003 | -5.734 | 5.919 | -0.094 |

Figure No. B.25. Computer Tabulated Force and Moment Data for Missile IV  
45° Roll, Fin No. 1, Blunt Nose

MISSILE III, ROLL 0, FIN 1, POINTED NOSE - III/O/F1/PT

RUN NUMBER IS 40  
DATA TAKEN 11:10:41 10-MAR-60

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMCO  | ROLCO  |
|----------------|--------|--------|--------|--------|-------|--------|
| -0.05          | -0.054 | 0.224  | -0.016 | 0.084  | 0.027 | -0.009 |
| 2.32           | 0.374  | 0.218  | -0.017 | -0.268 | 0.025 | -0.017 |
| 4.31           | 0.775  | 0.207  | -0.031 | -0.600 | 0.040 | -0.024 |
| 6.07           | 1.127  | 0.195  | -0.024 | -0.947 | 0.035 | -0.026 |
| 8.32           | 1.637  | 0.176  | -0.035 | -1.479 | 0.033 | -0.031 |
| 10.29          | 2.154  | 0.158  | -0.030 | -2.018 | 0.051 | -0.037 |
| 12.28          | 2.727  | 0.143  | -0.033 | -2.638 | 0.043 | -0.046 |
| 13.74          | 3.114  | 0.128  | -0.041 | -3.040 | 0.068 | -0.054 |
| 15.74          | 3.621  | 0.092  | -0.062 | -3.573 | 0.083 | -0.058 |
| 17.77          | 4.158  | 0.054  | -0.057 | -4.143 | 0.141 | -0.072 |
| 19.73          | 4.668  | 0.021  | -0.057 | -4.648 | 0.194 | -0.097 |
| 22.26          | 5.391  | -0.027 | -0.040 | -5.376 | 0.246 | -0.144 |
| 24.20          | 5.984  | -0.070 | -0.031 | -5.941 | 0.293 | -0.191 |
| 26.23          | 6.565  | -0.106 | -0.064 | -6.422 | 0.235 | -0.167 |
| 27.71          | 6.929  | -0.124 | -0.081 | -6.643 | 0.226 | -0.147 |
| 30.00          | 7.268  | -0.119 | -0.116 | -6.297 | 0.171 | -0.088 |

Figure B.26. Computer Tabulated Force and Moment Data for Missile III  
0° Roll, Fin No. 1, Pointed Nose

RUN NUMBER IS 41  
DATA TAKEN 11:18:52 10-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YNCO   | ROLEO  |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.16          | 0.101 | 0.210  | -0.047 | 0.138  | -0.040 | 0.000  |
| 2.17           | 0.180 | 0.212  | -0.204 | -0.170 | 0.092  | -0.007 |
| 4.36           | 0.835 | 0.193  | -0.365 | -0.497 | 0.254  | -0.015 |
| 6.37           | 1.184 | 0.175  | -0.532 | -0.855 | 0.438  | -0.024 |
| 7.86           | 1.493 | 0.162  | -0.692 | -1.180 | 0.633  | -0.025 |
| 10.22          | 2.052 | 0.147  | -0.988 | -1.805 | 0.926  | -0.040 |
| 12.00          | 2.480 | 0.131  | -1.262 | -2.301 | 1.329  | -0.049 |
| 14.20          | 3.028 | 0.097  | -1.586 | -2.871 | 1.697  | -0.036 |
| 16.29          | 3.544 | 0.066  | -1.885 | -3.388 | 2.007  | -0.022 |
| 17.99          | 3.940 | 0.039  | -2.170 | -3.792 | 2.267  | 0.006  |
| 19.80          | 4.420 | 0.016  | -2.494 | -4.285 | 2.563  | 0.064  |
| 22.24          | 5.113 | -0.019 | -2.988 | -4.787 | 2.948  | 0.162  |
| 24.18          | 5.657 | -0.046 | -3.412 | -5.041 | 3.329  | 0.154  |
| 26.23          | 6.014 | -0.045 | -3.773 | -4.938 | 3.462  | 0.078  |
| 28.29          | 6.511 | -0.071 | -4.076 | -4.937 | 3.597  | -0.037 |
| 30.00          | 6.891 | -0.075 | -4.345 | -4.873 | 3.887  | -0.077 |

Figure B.27. Computer Tabulated Force and Moment Data for Missile III  
22° Roll, Fin No. 1, Pointed Nose



RUN NUMBER IS 42  
DATA TAKEN 11:27:17 10-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMCO   | ROI CO |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.08          | 0.047 | 0.206  | -0.067 | 0.141  | -0.124 | 0.000  |
| 2.32           | 0.365 | 0.207  | -0.370 | -0.133 | 0.140  | -0.007 |
| 4.54           | 0.658 | 0.189  | -0.679 | -0.412 | 0.425  | -0.012 |
| 6.43           | 0.931 | 0.181  | -0.950 | -0.674 | 0.702  | -0.018 |
| 8.26           | 1.222 | 0.164  | -1.257 | -1.036 | 1.079  | -0.024 |
| 10.28          | 1.630 | 0.145  | -1.678 | -1.525 | 1.571  | -0.030 |
| 12.29          | 2.079 | 0.128  | -2.152 | -2.033 | 2.110  | -0.037 |
| 13.96          | 2.467 | 0.113  | -2.571 | -2.463 | 2.588  | -0.033 |
| 16.30          | 3.043 | 0.079  | -3.165 | -3.003 | 3.137  | -0.039 |
| 18.30          | 3.516 | 0.077  | -3.657 | -3.388 | 3.550  | -0.037 |
| 19.77          | 3.920 | 0.054  | -4.067 | -3.709 | 3.873  | -0.043 |
| 22.24          | 4.609 | 0.028  | -4.802 | -4.302 | 4.544  | -0.061 |
| 24.18          | 5.238 | -0.013 | -5.460 | -4.599 | 4.825  | -0.088 |
| 26.23          | 5.889 | -0.035 | -6.189 | -4.909 | 5.215  | -0.081 |
| 27.79          | 6.342 | -0.068 | -6.713 | -5.075 | 5.403  | -0.081 |
| 30.00          | 7.133 | -0.107 | -7.515 | -5.251 | 5.540  | -0.080 |

Figure B.28. Computer Tabulated Force and Moment Data for Missile III  
45° Roll, Fin No. 1, Pointed Nose

RUN NUMBER IS 43  
DATA TAKEN 13:35:32 10-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMCN  | ROLCO  |
|----------------|--------|--------|--------|--------|-------|--------|
| -0.09          | -0.114 | 0.272  | 0.001  | 0.096  | 0.012 | -0.015 |
| 2.12           | 0.358  | 0.278  | 0.007  | -0.458 | 0.022 | -0.019 |
| 4.28           | 0.776  | 0.257  | -0.002 | -0.985 | 0.017 | -0.022 |
| 6.32           | 1.201  | 0.238  | -0.014 | -1.536 | 0.033 | -0.025 |
| 8.28           | 1.711  | 0.225  | -0.012 | -2.186 | 0.050 | -0.029 |
| 10.25          | 2.248  | 0.205  | -0.043 | -2.922 | 0.085 | -0.041 |
| 12.30          | 2.809  | 0.178  | -0.049 | -3.661 | 0.095 | -0.042 |
| 13.73          | 3.195  | 0.155  | -0.062 | -4.131 | 0.091 | -0.038 |
| 15.84          | 3.719  | 0.109  | -0.067 | -4.795 | 0.085 | -0.033 |
| 18.01          | 4.252  | 0.057  | -0.054 | -5.445 | 0.090 | -0.038 |
| 20.15          | 4.779  | 0.023  | -0.077 | -6.038 | 0.112 | -0.046 |
| 22.25          | 5.317  | -0.018 | -0.089 | -6.564 | 0.124 | -0.045 |
| 24.20          | 5.812  | -0.061 | -0.085 | -7.068 | 0.144 | -0.052 |
| 26.26          | 6.341  | -0.102 | -0.127 | -7.544 | 0.184 | -0.057 |
| 28.08          | 6.671  | -0.125 | -0.118 | -7.744 | 0.190 | -0.093 |
| 30.00          | 7.095  | -0.144 | -0.100 | -7.875 | 0.018 | -0.134 |

Figure B.29. Computer Tabulated Force and Moment Data for Missile III  
0° Roll, Fin No. 2, Blunt Nose

RUN NUMBER IS 44  
DATA TAKEN 13:48:13 10-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMC0   | ROLCO  |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.10          | -0.040 | 0.266  | 0.038  | 0.115  | -0.045 | -0.008 |
| 2.38           | 0.409  | 0.265  | -0.154 | -0.419 | 0.162  | -0.013 |
| 4.36           | 0.783  | 0.253  | -0.309 | -0.897 | 0.388  | -0.018 |
| 6.33           | 1.141  | 0.233  | -0.489 | -1.376 | 0.631  | -0.026 |
| 8.24           | 1.404  | 0.214  | -0.720 | -1.980 | 0.972  | -0.030 |
| 10.28          | 2.107  | 0.185  | -0.997 | -2.680 | 1.388  | -0.042 |
| 11.88          | 2.503  | 0.167  | -1.212 | -3.211 | 1.686  | -0.043 |
| 14.27          | 3.080  | 0.136  | -1.550 | -3.954 | 2.118  | -0.034 |
| 16.33          | 3.561  | 0.100  | -1.828 | -4.537 | 2.413  | -0.037 |
| 18.37          | 4.027  | 0.071  | -2.178 | -5.068 | 2.903  | -0.055 |
| 20.08          | 4.407  | 0.030  | -2.406 | -5.433 | 3.160  | -0.100 |
| 22.25          | 4.889  | 0.010  | -2.650 | -5.909 | 3.392  | -0.202 |
| 24.18          | 5.389  | -0.030 | -2.940 | -6.356 | 3.401  | -0.249 |
| 26.27          | 5.944  | -0.074 | -3.234 | -6.871 | 3.450  | -0.268 |
| 28.30          | 6.350  | -0.077 | -3.598 | -7.182 | 3.389  | -0.292 |
| 30.00          | 6.718  | -0.094 | -3.947 | -7.260 | 3.511  | -0.339 |

Figure B.30. Computer Tabulated Force and Moment Data for Missile III  
22° Roll, Fin No. 2, Blunt Nose

RUN NUMBER IS 45  
DATA TAKEN 14:28:39 10-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN    | CA     | CY     | CM     | YMC0  | ROI C0 |
|----------------|-------|--------|--------|--------|-------|--------|
| 0.35           | 0.008 | 0.277  | 0.013  | -0.032 | 0.011 | -0.009 |
| 2.22           | 0.259 | 0.274  | -0.254 | -0.342 | 0.716 | -0.013 |
| 4.19           | 0.560 | 0.261  | -0.533 | -0.713 | 0.604 | -0.017 |
| 6.40           | 0.891 | 0.240  | -0.868 | -1.140 | 1.132 | -0.025 |
| 8.16           | 1.220 | 0.228  | -1.206 | -1.605 | 1.603 | -0.028 |
| 10.27          | 1.639 | 0.212  | -1.631 | -2.196 | 2.200 | -0.038 |
| 12.27          | 2.079 | 0.195  | -2.075 | -2.817 | 2.833 | -0.053 |
| 14.00          | 2.441 | 0.168  | -2.434 | -3.282 | 3.290 | -0.048 |
| 16.21          | 2.897 | 0.133  | -2.929 | -3.851 | 3.840 | -0.035 |
| 17.90          | 3.310 | 0.104  | -3.340 | -4.398 | 4.355 | -0.015 |
| 19.75          | 3.713 | 0.073  | -3.776 | -4.889 | 4.843 | -0.013 |
| 22.23          | 4.371 | 0.039  | -4.475 | -5.465 | 5.570 | 0.000  |
| 24.21          | 4.991 | 0.008  | -5.074 | -6.238 | 6.120 | 0.016  |
| 26.26          | 5.641 | -0.034 | -5.750 | -6.802 | 6.517 | 0.098  |
| 28.12          | 6.219 | -0.069 | -6.391 | -7.181 | 6.808 | 0.092  |
| 30.00          | 6.808 | -0.113 | -7.040 | -7.306 | 7.105 | 0.027  |

Figure B.31. Computer Tabulated Force and Moment Data for Missile III  
45° Roll, Fin No. 2, Blunt Nose

RUN NUMBER IS 46  
DATA TAKEN 14:48:26 10-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMCO  | ROLCO  |
|----------------|--------|--------|--------|--------|-------|--------|
| -0.18          | -0.119 | 0.272  | 0.000  | 0.085  | 0.013 | -0.015 |
| 2.28           | 0.357  | 0.262  | 0.006  | -0.468 | 0.011 | -0.020 |
| 4.37           | 0.757  | 0.252  | 0.004  | -1.002 | 0.012 | -0.022 |
| 6.37           | 1.204  | 0.228  | -0.003 | -1.515 | 0.027 | -0.026 |
| 8.32           | 1.691  | 0.213  | -0.011 | -2.139 | 0.056 | -0.034 |
| 10.27          | 2.241  | 0.192  | -0.021 | -2.874 | 0.089 | -0.050 |
| 12.28          | 2.806  | 0.156  | -0.029 | -3.576 | 0.094 | -0.052 |
| 14.27          | 3.339  | 0.124  | -0.051 | -4.228 | 0.103 | -0.051 |
| 16.30          | 3.838  | 0.082  | -0.044 | -4.815 | 0.090 | -0.044 |
| 17.80          | 4.229  | 0.048  | -0.034 | -5.266 | 0.131 | -0.063 |
| 20.30          | 4.821  | 0.007  | -0.017 | -5.857 | 0.131 | -0.085 |
| 22.24          | 5.304  | -0.031 | -0.005 | -6.315 | 0.151 | -0.112 |
| 24.20          | 5.817  | -0.069 | -0.002 | -6.735 | 0.167 | -0.141 |
| 26.21          | 6.345  | -0.114 | -0.043 | -7.106 | 0.193 | -0.097 |
| 28.12          | 6.712  | -0.130 | -0.067 | -7.243 | 0.231 | -0.070 |
| 30.00          | 7.101  | -0.143 | -0.129 | -7.288 | 0.204 | -0.081 |

Figure B.32. Computer Tabulated Force and Moment Data for Missile III  
0° Roll, Fin No. 2, Pointed Nose

RUN NUMBER IS 47  
DATA TAKEN 15:01:31 10-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMCO   | ROL CO |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.04          | -0.054 | 0.260  | 0.042  | 0.088  | -0.052 | -0.005 |
| 2.38           | 0.403  | 0.262  | -0.158 | -0.441 | 0.156  | -0.010 |
| 4.22           | 0.755  | 0.248  | -0.299 | -0.888 | 0.366  | -0.016 |
| 6.27           | 1.164  | 0.226  | -0.474 | -1.375 | 0.628  | -0.022 |
| 7.84           | 1.482  | 0.202  | -0.655 | -1.830 | 0.868  | -0.026 |
| 10.28          | 2.097  | 0.182  | -0.976 | -2.629 | 1.365  | -0.048 |
| 12.30          | 2.593  | 0.155  | -1.266 | -3.234 | 1.736  | -0.052 |
| 14.24          | 3.093  | 0.123  | -1.555 | -3.793 | 2.065  | -0.041 |
| 16.29          | 3.596  | 0.090  | -1.834 | -4.349 | 2.404  | -0.051 |
| 17.72          | 3.864  | 0.070  | -2.053 | -4.652 | 2.711  | -0.062 |
| 20.28          | 4.462  | 0.028  | -2.464 | -5.214 | 3.176  | -0.109 |
| 22.23          | 4.942  | -0.004 | -2.772 | -5.647 | 3.422  | -0.174 |
| 24.18          | 5.509  | -0.043 | -2.956 | -6.039 | 3.579  | -0.284 |
| 26.26          | 6.007  | -0.077 | -3.185 | -6.347 | 3.540  | -0.348 |
| 28.29          | 6.380  | -0.095 | -3.517 | -6.396 | 3.559  | -0.366 |
| 30.00          | 6.872  | -0.113 | -3.632 | -6.516 | 3.566  | -0.431 |

Figure B.33. Computer Tabulated Force and Moment Data for Missile III  
22° Roll, Fin No. 2, Pointed Nose

RUN NUMBER IS 48  
DATA TAKEN 15:13:54 10-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMC0   | ROLCO  |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.21          | -0.071 | 0.249  | 0.110  | 0.098  | -0.130 | -0.005 |
| 2.24           | 0.298  | 0.247  | -0.270 | -0.342 | 0.293  | -0.012 |
| 4.35           | 0.563  | 0.229  | -0.549 | -0.687 | 0.656  | -0.017 |
| 6.32           | 0.888  | 0.210  | -0.862 | -1.077 | 1.083  | -0.023 |
| 8.29           | 1.239  | 0.188  | -1.230 | -1.577 | 1.575  | -0.029 |
| 10.27          | 1.659  | 0.174  | -1.652 | -2.144 | 2.160  | -0.041 |
| 12.30          | 2.099  | 0.154  | -2.116 | -2.696 | 2.752  | -0.054 |
| 14.22          | 2.529  | 0.132  | -2.577 | -3.182 | 3.272  | -0.063 |
| 16.29          | 2.980  | 0.101  | -3.039 | -3.656 | 3.779  | -0.059 |
| 17.75          | 3.326  | 0.075  | -3.395 | -4.017 | 4.196  | -0.038 |
| 20.30          | 3.962  | 0.020  | -4.124 | -4.738 | 4.957  | -0.034 |
| 22.25          | 4.533  | -0.008 | -4.681 | -5.242 | 5.403  | -0.022 |
| 24.18          | 5.161  | -0.042 | -5.309 | -5.719 | 5.863  | -0.023 |
| 26.23          | 5.814  | -0.084 | -5.967 | -6.050 | 6.125  | -0.032 |
| 28.28          | 6.426  | -0.120 | -6.616 | -6.205 | 6.321  | -0.063 |
| 30.00          | 7.030  | -0.180 | -7.140 | -6.309 | 6.462  | -0.106 |

Figure B.34. Computer Tabulated Force and Moment Data for Missile III  
45° Roll, Fin No. 2, Pointed Nose

RUN NUMBER IS 51  
DATA TAKEN 16:11:18 10-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMC0   | ROL.CO |
|----------------|--------|--------|--------|--------|--------|--------|
| 0.25           | -0.024 | 0.263  | 0.016  | 0.006  | -0.001 | -0.015 |
| 2.30           | 0.331  | 0.244  | 0.010  | -0.197 | 0.001  | -0.017 |
| 4.17           | 0.730  | 0.251  | 0.008  | -0.197 | 0.000  | -0.021 |
| 6.33           | 1.206  | 0.230  | -0.011 | -0.581 | 0.009  | -0.024 |
| 8.33           | 1.704  | 0.227  | -0.003 | -1.354 | 0.012  | -0.028 |
| 10.12          | 2.269  | 0.220  | -0.012 | -1.745 | 0.030  | -0.032 |
| 12.29          | 2.955  | 0.201  | -0.027 | -2.676 | 0.021  | -0.030 |
| 14.25          | 3.567  | 0.186  | -0.037 | -3.313 | 0.030  | -0.033 |
| 15.95          | 4.070  | 0.158  | -0.039 | -3.848 | 0.034  | -0.036 |
| 18.20          | 4.759  | 0.119  | -0.055 | -4.551 | 0.044  | -0.035 |
| 20.24          | 5.451  | 0.085  | -0.082 | -5.266 | 0.079  | -0.032 |
| 22.24          | 6.117  | 0.053  | -0.087 | -5.959 | 0.106  | -0.038 |
| 24.19          | 6.857  | 0.010  | -0.098 | -6.706 | 0.105  | -0.035 |
| 26.24          | 7.551  | -0.035 | -0.092 | -7.400 | 0.036  | -0.049 |
| 28.29          | 8.067  | -0.037 | -0.147 | -7.596 | 0.194  | -0.065 |
| 30.00          | 8.605  | -0.037 | -0.176 | -7.944 | 0.137  | -0.036 |

Figure B.35. Computer Tabulated Force and Moment Data for Missile III  
0° Roll, Fin No. 3, Blunt Nose



RUN NUMBER IS 52  
DATA TAKEN 16127119 10-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMCN   | ROLCO  |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.21          | -0.055 | 0.243  | 0.040  | 0.109  | -0.050 | -0.011 |
| 2.23           | 0.356  | 0.249  | -0.146 | -0.128 | 0.055  | -0.014 |
| 4.38           | 0.744  | 0.238  | -0.323 | -0.415 | 0.208  | -0.021 |
| 5.70           | 1.018  | 0.229  | -0.436 | -0.643 | 0.329  | -0.025 |
| 8.31           | 1.614  | 0.211  | -0.759 | -1.220 | 0.686  | -0.039 |
| 10.21          | 2.168  | 0.199  | -1.063 | -1.799 | 1.039  | -0.044 |
| 12.29          | 2.789  | 0.173  | -1.435 | -2.507 | 1.474  | -0.023 |
| 14.29          | 3.389  | 0.149  | -1.771 | -3.180 | 1.848  | 0.009  |
| 15.92          | 3.861  | 0.123  | -2.055 | -3.696 | 2.156  | 0.034  |
| 17.72          | 4.373  | 0.094  | -2.395 | -4.258 | 2.533  | 0.069  |
| 19.73          | 5.022  | 0.067  | -2.827 | -4.950 | 2.973  | 0.146  |
| 22.25          | 5.859  | 0.038  | -3.393 | -5.728 | 3.530  | 0.269  |
| 24.18          | 6.471  | 0.010  | -3.722 | -6.147 | 3.477  | 0.320  |
| 26.22          | 7.101  | -0.019 | -4.124 | -6.533 | 3.651  | 0.338  |
| 28.04          | 7.585  | -0.037 | -4.461 | -6.755 | 3.752  | 0.395  |
| 30.00          | 8.273  | -0.082 | -4.944 | -7.143 | 3.817  | 0.502  |

Figure B.36. Computer Tabulated Force and Moment Data for Missile III  
22° Roll, Fin No. 3, Blunt Nose

RUN NUMBER IS 33  
DATA TAKEN 07:56:54 11-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMC0   | ROLCO  |
|----------------|--------|--------|--------|--------|--------|--------|
| 0.12           | -0.038 | 0.266  | 0.057  | 0.021  | -0.025 | -0.014 |
| 2.10           | 0.206  | 0.256  | -0.195 | -0.124 | 0.122  | -0.017 |
| 4.22           | 0.522  | 0.243  | -0.306 | -0.373 | 0.366  | -0.020 |
| 6.57           | 0.866  | 0.236  | -0.470 | -0.681 | 0.676  | -0.025 |
| 8.17           | 1.216  | 0.226  | -1.212 | -1.042 | 1.058  | -0.033 |
| 10.12          | 1.724  | 0.212  | -1.736 | -1.629 | 1.645  | -0.031 |
| 12.22          | 2.279  | 0.188  | -2.286 | -2.248 | 2.253  | -0.033 |
| 14.16          | 2.774  | 0.179  | -2.798 | -2.827 | 2.803  | -0.022 |
| 16.34          | 3.356  | 0.151  | -3.388 | -3.482 | 3.442  | -0.015 |
| 18.16          | 3.853  | 0.124  | -3.901 | -4.022 | 3.986  | -0.014 |
| 19.73          | 4.316  | 0.097  | -4.384 | -4.520 | 4.490  | -0.005 |
| 22.27          | 5.163  | 0.062  | -5.280 | -5.408 | 5.361  | 0.036  |
| 24.21          | 5.884  | 0.042  | -6.042 | -6.099 | 6.027  | 0.077  |
| 26.26          | 6.713  | 0.007  | -6.924 | -6.771 | 6.719  | 0.070  |
| 28.20          | 7.451  | -0.028 | -7.692 | -7.260 | 7.245  | 0.100  |
| 30.00          | 8.251  | -0.053 | -8.492 | -7.523 | 7.703  | 0.037  |

Figure B.37. Computer Tabulated Force and Moment Data for Missile III  
45° Roll, Fin No. 3, Blunt Nose

RUN NUMBER IS 54  
DATA TAKEN 08113:24 11-MAR-80

## COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CN     | YNCO   | ROLCO  |
|----------------|--------|--------|--------|--------|--------|--------|
| 0.20           | -0.074 | 0.252  | 0.014  | 0.018  | -0.009 | -0.014 |
| 2.13           | 0.302  | 0.245  | 0.016  | -0.209 | 0.000  | -0.017 |
| 4.45           | 0.739  | 0.238  | 0.014  | -0.521 | -0.006 | -0.024 |
| 6.38           | 1.140  | 0.221  | 0.014  | -0.846 | -0.001 | -0.026 |
| 8.10           | 1.636  | 0.221  | 0.000  | -1.284 | 0.004  | -0.030 |
| 10.12          | 2.242  | 0.209  | -0.013 | -1.702 | 0.015  | -0.035 |
| 12.27          | 2.907  | 0.188  | -0.018 | -2.580 | 0.025  | -0.038 |
| 13.73          | 3.402  | 0.178  | -0.014 | -3.073 | 0.036  | -0.045 |
| 16.18          | 4.134  | 0.150  | -0.022 | -3.804 | 0.048  | -0.050 |
| 18.18          | 4.754  | 0.112  | -0.040 | -4.389 | 0.072  | -0.065 |
| 19.71          | 5.235  | 0.086  | -0.041 | -4.856 | 0.120  | -0.083 |
| 22.28          | 6.164  | 0.042  | -0.035 | -5.752 | 0.197  | -0.126 |
| 24.22          | 6.894  | 0.000  | -0.054 | -6.434 | 0.224  | -0.145 |
| 25.77          | 7.496  | -0.036 | -0.061 | -7.012 | 0.199  | -0.118 |
| 27.85          | 8.014  | -0.042 | -0.092 | -7.141 | 0.307  | -0.135 |
| 30.00          | 8.684  | -0.076 | -0.169 | -7.449 | 0.227  | -0.104 |

Figure B.38. Computer Tabulated Force and Moment Data for Missile III  
0° Roll, Fin No. 3, Pointed Nose

MISSILE III, ROLL 22.5, FIN 3, POINTED NO - III/22.5/F3/PT

RUN NUMBER IS 55  
DATA TAKEN 08:25:25 11-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMCN   | ROLCO  |
|----------------|--------|--------|--------|--------|--------|--------|
| 0.02           | -0.055 | 0.239  | 0.034  | 0.074  | -0.037 | -0.014 |
| 2.24           | 0.348  | 0.242  | -0.129 | -0.147 | 0.053  | -0.016 |
| 4.32           | 0.689  | 0.225  | -0.301 | -0.400 | 0.150  | -0.022 |
| 6.20           | 1.120  | 0.224  | -0.500 | -0.749 | 0.389  | -0.031 |
| 8.20           | 1.568  | 0.201  | -0.727 | -1.175 | 0.634  | -0.040 |
| 10.27          | 2.174  | 0.191  | -1.059 | -1.706 | 1.034  | -0.049 |
| 12.30          | 2.792  | 0.165  | -1.418 | -2.437 | 1.433  | -0.031 |
| 14.10          | 3.367  | 0.141  | -1.762 | -3.042 | 1.804  | -0.003 |
| 16.07          | 3.932  | 0.120  | -2.113 | -3.609 | 2.152  | 0.040  |
| 18.37          | 4.470  | 0.082  | -2.571 | -4.260 | 2.567  | 0.099  |
| 20.05          | 5.194  | 0.066  | -2.941 | -4.707 | 2.847  | 0.162  |
| 22.25          | 5.907  | 0.028  | -3.534 | -5.390 | 3.399  | 0.343  |
| 24.22          | 6.601  | 0.003  | -3.835 | -5.792 | 3.519  | 0.250  |
| 26.23          | 7.232  | -0.004 | -4.292 | -6.022 | 3.703  | 0.325  |
| 28.13          | 7.770  | -0.038 | -4.779 | -6.151 | 3.974  | 0.315  |
| 30.00          | 8.424  | -0.084 | -5.103 | -6.317 | 3.973  | 0.327  |

Figure B.39. Computer Tabulated Force and Moment Data for Missile III  
22° Roll, Fin No. 3, Pointed Nose

MISSILE III, ROLL 45, FIN 3, POINTED NOS - III/45/F3/PT

RUN NUMBER IS 56  
DATA TAKEN 08:37:50 11-MAR-80

COEFFICIENTS ABOUT THE BODY AXIS

| ALPHA<br>(DEG) | CN     | CA     | CY     | CM     | YMCN   | ROLCO  |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.19          | -0.050 | 0.249  | 0.074  | 0.090  | -0.106 | -0.013 |
| 2.15           | 0.286  | 0.249  | -0.236 | -0.112 | 0.081  | -0.017 |
| 3.88           | 0.508  | 0.236  | -0.475 | -0.279 | 0.250  | -0.022 |
| 6.30           | 0.926  | 0.218  | -0.905 | -0.645 | 0.610  | -0.028 |
| 8.26           | 1.287  | 0.207  | -1.277 | -0.997 | 1.007  | -0.035 |
| 10.30          | 1.773  | 0.189  | -1.781 | -1.567 | 1.579  | -0.039 |
| 12.26          | 2.336  | 0.173  | -2.355 | -2.145 | 2.180  | -0.045 |
| 14.27          | 2.874  | 0.163  | -2.915 | -2.678 | 2.758  | -0.063 |
| 16.22          | 3.386  | 0.140  | -3.447 | -3.197 | 3.254  | -0.068 |
| 17.72          | 3.793  | 0.108  | -3.863 | -3.577 | 3.621  | -0.067 |
| 19.74          | 4.419  | 0.082  | -4.491 | -4.126 | 4.155  | -0.070 |
| 22.27          | 5.285  | 0.056  | -5.339 | -4.776 | 4.763  | -0.068 |
| 24.23          | 6.107  | 0.034  | -6.164 | -5.243 | 5.264  | -0.088 |
| 26.23          | 6.862  | 0.006  | -6.953 | -5.577 | 5.642  | -0.089 |
| 28.24          | 7.609  | -0.026 | -7.683 | -5.855 | 5.881  | -0.096 |
| 30.00          | 8.570  | -0.415 | -8.705 | -6.230 | 6.273  | -0.145 |

Figure B.40. Computer Tabulated Force and Moment Data for Missile III  
45° Roll, Fin No. 3, Pointed Nose

RUN NUMBER IS 1  
DATA TAKEN 16122139 13-JAN-82

COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL     | CD     | CC     | CN     | CNW    | CLW   |
|----------------|--------|--------|--------|--------|--------|-------|
| 0.16           | -0.002 | 0.1438 | -0.020 | -0.031 | 0.021  | 0.021 |
| 2.10           | 0.108  | 0.1511 | -0.023 | 0.271  | 0.015  | 0.015 |
| 4.18           | 0.235  | 0.1645 | -0.044 | 0.563  | 0.011  | 0.015 |
| 6.10           | 0.403  | 0.1908 | -0.072 | 0.871  | 0.010  | 0.033 |
| 7.97           | 0.599  | 0.2298 | -0.108 | 1.220  | -0.005 | 0.046 |
| 9.90           | 0.838  | 0.2819 | -0.176 | 1.566  | 0.019  | 0.093 |
| 11.92          | 1.085  | 0.3672 | -0.279 | 1.931  | 0.045  | 0.207 |
| 13.87          | 1.325  | 0.4585 | -0.408 | 2.263  | 0.086  | 0.384 |
| 15.93          | 1.687  | 0.5861 | -0.596 | 2.614  | 0.229  | 0.568 |
| 17.95          | 1.957  | 0.7298 | -0.839 | 2.935  | 0.376  | 0.808 |
| 19.97          | 2.284  | 0.9077 | -1.155 | 3.261  | 0.655  | 1.237 |
| 21.84          | 2.630  | 1.1168 | -1.501 | 3.536  | 0.968  | 1.548 |
| 23.95          | 3.047  | 1.3724 | -1.959 | 3.886  | 1.377  | 1.862 |
| 26.32          | 3.304  | 1.6865 | -2.493 | 4.253  | 1.810  | 2.031 |
| 27.98          | 3.803  | 1.9239 | -2.782 | 4.447  | 1.938  | 1.924 |
| 29.70          | 4.198  | 2.2394 | -3.099 | 4.594  | 1.942  | 1.643 |

Figure B.41. Computer Tabulated Force and Moment Data for Missile I  
11° Roll, No Fin, Blunt Nose

RUN NUMBER IS 2  
DATA TAKEN 08:13:56 14-JAN-82

COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW    | CLW    |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.36          | 0.021 | 0.1364 | -0.004 | -0.096 | 0.005  | 0.006  |
| 2.01           | 0.146 | 0.1487 | -0.016 | 0.231  | -0.001 | -0.001 |
| 4.10           | 0.284 | 0.1736 | -0.014 | 0.541  | 0.001  | 0.003  |
| 5.99           | 0.473 | 0.2067 | -0.025 | 0.830  | 0.001  | 0.004  |
| 7.89           | 0.700 | 0.2471 | -0.051 | 1.168  | 0.004  | 0.006  |
| 9.63           | 0.976 | 0.3137 | -0.083 | 1.471  | 0.016  | 0.031  |
| 11.72          | 1.369 | 0.4239 | -0.137 | 1.739  | 0.038  | 0.083  |
| 13.74          | 1.794 | 0.5626 | -0.201 | 1.970  | 0.093  | 0.144  |
| 15.78          | 2.229 | 0.7358 | -0.296 | 2.200  | 0.116  | 0.273  |
| 17.96          | 2.787 | 0.9783 | -0.427 | 2.477  | 0.196  | 0.422  |
| 19.90          | 3.262 | 1.2367 | -0.566 | 2.740  | 0.379  | 0.485  |
| 21.97          | 3.868 | 1.5788 | -0.747 | 3.105  | 0.505  | 0.655  |
| 23.98          | 4.476 | 1.9542 | -0.957 | 3.462  | 0.720  | 0.778  |
| 25.99          | 5.048 | 2.3689 | -1.195 | 3.873  | 0.949  | 0.902  |
| 27.98          | 5.589 | 2.8201 | -1.448 | 4.293  | 1.266  | 0.985  |
| 29.72          | 6.003 | 3.2318 | -1.720 | 4.691  | 1.589  | 1.030  |

Figure B.42. Computer Tabulated Force and Moment Data for Missile I  
33° Roll, No Fin, Blunt Nose

MISSILE II, ROLL 11.25, NO FIN, BLUNT NOSE - II/11/NF/BL

RUN NUMBER IS 3  
DATA TAKEN 15:48:24 13-JAN-82

COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CI    | CD     | CC     | CM    | CNW    | CLW    |
|----------------|-------|--------|--------|-------|--------|--------|
| 0.13           | 0.016 | 0.1364 | -0.004 | 0.002 | 0.011  | 0.011  |
| 2.01           | 0.085 | 0.1472 | -0.012 | 0.267 | 0.001  | 0.003  |
| 4.15           | 0.197 | 0.1620 | -0.005 | 0.586 | -0.005 | -0.003 |
| 6.03           | 0.301 | 0.1780 | -0.008 | 0.880 | -0.001 | -0.003 |
| 7.89           | 0.448 | 0.2030 | -0.030 | 1.190 | 0.001  | 0.011  |
| 9.87           | 0.574 | 0.2361 | -0.084 | 1.511 | 0.013  | 0.028  |
| 11.96          | 0.782 | 0.2939 | -0.160 | 1.863 | 0.044  | 0.112  |
| 13.95          | 0.978 | 0.3555 | -0.257 | 2.178 | 0.120  | 0.187  |
| 15.91          | 1.182 | 0.4414 | -0.386 | 2.508 | 0.137  | 0.423  |
| 17.92          | 1.383 | 0.5390 | -0.560 | 2.818 | 0.332  | 0.581  |
| 20.01          | 1.599 | 0.6561 | -0.790 | 3.128 | 0.553  | 0.878  |
| 21.86          | 1.867 | 0.7936 | -1.067 | 3.415 | 0.853  | 1.174  |
| 23.66          | 2.149 | 0.9470 | -1.365 | 3.608 | 1.106  | 1.436  |
| 25.65          | 2.443 | 1.1377 | -1.703 | 3.765 | 1.323  | 1.647  |
| 28.00          | 2.792 | 1.3802 | -2.016 | 3.859 | 1.383  | 1.623  |
| 29.75          | 3.092 | 1.6149 | -2.239 | 3.907 | 1.237  | 1.565  |

Figure B.43. Computer Tabulated Force and Moment Data for Missile II  
11° Roll, No Fin, Blunt Nose



RUN NUMBER IS 4  
DATA TAKEN 16102112 13-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM    | CNW    | CLW    |
|----------------|-------|--------|--------|-------|--------|--------|
| 0.22           | 0.055 | 0.1348 | -0.072 | 0.081 | -0.007 | -0.007 |
| 2.05           | 0.176 | 0.1497 | -0.026 | 0.346 | 0.035  | 0.038  |
| 4.13           | 0.274 | 0.1709 | -0.037 | 0.633 | 0.034  | 0.043  |
| 6.12           | 0.422 | 0.1897 | -0.047 | 0.907 | 0.043  | 0.049  |
| 7.93           | 0.569 | 0.2235 | -0.064 | 1.201 | 0.052  | 0.047  |
| 9.90           | 0.812 | 0.2808 | -0.106 | 1.518 | 0.057  | 0.073  |
| 11.87          | 1.120 | 0.3589 | -0.185 | 1.727 | 0.121  | 0.162  |
| 13.92          | 1.496 | 0.4650 | -0.284 | 1.893 | 0.174  | 0.290  |
| 15.96          | 1.903 | 0.6201 | -0.419 | 2.034 | 0.238  | 0.487  |
| 17.97          | 2.354 | 0.8156 | -0.582 | 2.168 | 0.421  | 0.697  |
| 19.97          | 2.770 | 1.0390 | -0.795 | 2.362 | 0.701  | 0.872  |
| 21.86          | 3.240 | 1.3140 | -1.046 | 2.577 | 0.930  | 1.140  |
| 23.85          | 3.751 | 1.6515 | -1.332 | 2.849 | 1.235  | 1.329  |
| 25.71          | 4.240 | 1.9718 | -1.678 | 3.096 | 1.616  | 1.544  |
| 27.91          | 4.774 | 2.3800 | -2.107 | 3.383 | 2.151  | 1.739  |
| 29.70          | 5.213 | 2.7562 | -2.497 | 3.648 | 2.647  | 1.814  |

Figure B.44. Computer Tabulated Force and Moment Data for Missile II  
33° Roll, No Fin, Blunt Nose

RUN NUMBER IS 5  
DATA TAKEN 09118136 14-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL     | CD     | CC     | CM     | CNW    | CLW    |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.11          | -0.043 | 0.1452 | 0.005  | -0.079 | -0.001 | -0.001 |
| 2.00           | 0.047  | 0.1514 | -0.005 | 0.208  | 0.005  | 0.001  |
| 3.99           | 0.130  | 0.1518 | -0.004 | 0.485  | 0.004  | 0.001  |
| 5.96           | 0.220  | 0.1658 | -0.007 | 0.758  | 0.006  | 0.005  |
| 7.93           | 0.328  | 0.1874 | -0.016 | 1.065  | 0.025  | 0.001  |
| 9.83           | 0.442  | 0.2198 | -0.027 | 1.330  | 0.024  | 0.021  |
| 11.81          | 0.593  | 0.2586 | -0.034 | 1.602  | 0.054  | 0.024  |
| 13.81          | 0.698  | 0.2920 | -0.057 | 1.835  | 0.060  | 0.110  |
| 16.18          | 0.898  | 0.3553 | -0.112 | 2.120  | 0.092  | 0.198  |
| 17.91          | 1.032  | 0.4074 | -0.173 | 2.339  | 0.091  | 0.360  |
| 19.90          | 1.195  | 0.4852 | -0.277 | 2.586  | 0.357  | 0.371  |
| 21.88          | 1.343  | 0.5878 | -0.451 | 2.858  | 0.517  | 0.671  |
| 24.03          | 1.549  | 0.7186 | -0.708 | 3.130  | 0.789  | 1.060  |
| 26.32          | 1.766  | 0.8607 | -1.021 | 3.350  | 1.140  | 1.526  |
| 27.65          | 1.885  | 0.9387 | -1.166 | 3.452  | 1.318  | 1.700  |
| 29.57          | 2.054  | 1.0831 | -1.407 | 3.592  | 1.519  | 2.075  |

Figure B.45. Computer Tabulated Force and Moment Data for Missile III  
11° Roll, No Fin, Blunt Nose

RUN NUMBER 13 6  
DATA TAKEN 10:10:34 14-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW   | CLW    |
|----------------|-------|--------|--------|--------|-------|--------|
| 0.07           | 0.003 | 0.1528 | 0.000  | -0.029 | 0.018 | 0.018  |
| 1.76           | 0.062 | 0.1534 | -0.007 | 0.203  | 0.001 | 0.000  |
| 4.09           | 0.156 | 0.1537 | -0.002 | 0.493  | 0.002 | 0.004  |
| 6.05           | 0.263 | 0.1725 | -0.009 | 0.766  | 0.007 | 0.013  |
| 7.82           | 0.361 | 0.1930 | -0.018 | 1.036  | 0.013 | 0.027  |
| 9.74           | 0.510 | 0.2307 | -0.027 | 1.274  | 0.019 | 0.030  |
| 11.97          | 0.681 | 0.2751 | -0.003 | 1.510  | 0.040 | -0.008 |
| 13.88          | 0.869 | 0.3309 | -0.078 | 1.687  | 0.052 | 0.131  |
| 15.84          | 1.094 | 0.4067 | -0.139 | 1.804  | 0.197 | 0.155  |
| 17.90          | 1.441 | 0.5176 | -0.230 | 1.819  | 0.418 | 0.196  |
| 19.87          | 1.759 | 0.6775 | -0.399 | 1.906  | 0.631 | 0.468  |
| 21.77          | 2.079 | 0.8555 | -0.618 | 2.060  | 0.895 | 0.774  |
| 24.07          | 2.462 | 1.1025 | -0.924 | 2.164  | 1.460 | 1.068  |
| 25.97          | 2.908 | 1.3743 | -1.301 | 2.118  | 1.856 | 1.572  |
| 27.63          | 3.267 | 1.6321 | -1.591 | 2.066  | 2.427 | 1.746  |
| 29.62          | 3.703 | 1.9528 | -2.052 | 2.137  | 3.055 | 2.043  |

Figure B.46. Computer Tabulated Force and Moment Data for Missile III  
33° Roll, No Fin, Blunt Nose

RUN NUMBER IS 8  
DATA TAKEN 08:34:43 14-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL     | CD     | CC     | CM    | CNW   | CIW   |
|----------------|--------|--------|--------|-------|-------|-------|
| 0.04           | -0.021 | 0.1232 | -0.029 | 0.066 | 0.017 | 0.019 |
| 2.03           | 0.071  | 0.1349 | -0.032 | 0.197 | 0.015 | 0.018 |
| 4.01           | 0.133  | 0.1446 | -0.032 | 0.501 | 0.017 | 0.024 |
| 6.12           | 0.242  | 0.1600 | -0.043 | 0.835 | 0.017 | 0.034 |
| 7.89           | 0.339  | 0.1810 | -0.038 | 1.113 | 0.017 | 0.045 |
| 9.87           | 0.471  | 0.2198 | -0.047 | 1.434 | 0.030 | 0.043 |
| 12.01          | 0.629  | 0.2600 | -0.062 | 1.751 | 0.032 | 0.083 |
| 13.88          | 0.754  | 0.3003 | -0.092 | 1.995 | 0.046 | 0.148 |
| 16.00          | 0.938  | 0.3622 | -0.151 | 2.300 | 0.078 | 0.240 |
| 17.86          | 1.082  | 0.4329 | -0.225 | 2.635 | 0.260 | 0.265 |
| 19.85          | 1.288  | 0.5153 | -0.296 | 2.970 | 0.338 | 0.416 |
| 21.82          | 1.445  | 0.6245 | -0.398 | 3.288 | 0.460 | 0.622 |
| 23.96          | 1.645  | 0.7673 | -0.574 | 3.604 | 0.634 | 0.971 |
| 26.23          | 1.928  | 0.9327 | -0.698 | 3.893 | 0.884 | 1.346 |
| 28.14          | 2.111  | 1.0650 | -0.939 | 4.126 | 1.222 | 1.742 |
| 29.67          | 2.270  | 1.1788 | -1.144 | 4.298 | 1.466 | 2.090 |

Figure B.47. Computer Tabulated Force and Moment Data for Missile III  
11° Roll No Fin, Pointed Nose

RUN NUMBER IS 9  
DATA TAKEN 08:54:00 14-JAN-82

COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW   | CIW   |
|----------------|-------|--------|--------|--------|-------|-------|
| -0.32          | 0.024 | 0.1200 | -0.093 | -0.023 | 0.037 | 0.056 |
| 2.02           | 0.181 | 0.1338 | -0.048 | 0.245  | 0.032 | 0.042 |
| 4.07           | 0.271 | 0.1495 | -0.072 | 0.576  | 0.035 | 0.053 |
| 6.06           | 0.370 | 0.1700 | -0.075 | 0.837  | 0.032 | 0.064 |
| 7.90           | 0.462 | 0.1806 | -0.074 | 1.153  | 0.033 | 0.067 |
| 9.88           | 0.506 | 0.2199 | -0.081 | 1.446  | 0.015 | 0.074 |
| 11.66          | 0.819 | 0.2807 | -0.111 | 1.666  | 0.084 | 0.094 |
| 14.08          | 1.077 | 0.3594 | -0.190 | 1.874  | 0.210 | 0.178 |
| 15.97          | 1.353 | 0.4512 | -0.289 | 2.063  | 0.412 | 0.213 |
| 17.94          | 1.620 | 0.5755 | -0.423 | 2.208  | 0.541 | 0.424 |
| 19.90          | 1.941 | 0.7413 | -0.520 | 2.355  | 0.803 | 0.599 |
| 22.19          | 2.343 | 0.9851 | -0.774 | 2.538  | 1.431 | 0.728 |
| 24.30          | 2.779 | 1.2548 | -1.122 | 2.738  | 1.920 | 1.117 |
| 26.12          | 3.166 | 1.5203 | -1.397 | 2.927  | 2.186 | 1.398 |
| 27.90          | 3.694 | 1.8703 | -1.678 | 3.010  | 2.590 | 1.502 |
| 29.61          | 4.183 | 2.2260 | -2.036 | 3.104  | 3.032 | 1.679 |

Figure B.48. Computer Tabulated Force and Moment Data for Missile III  
33° Roll, No Fin, Pointed Nose

RUN NUMBER IS 10  
 DATA TAKEN 11:18:40 14-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW    | CLW   |
|----------------|-------|--------|--------|--------|--------|-------|
| 0.14           | 0.034 | 0.2259 | -0.046 | -0.045 | 0.041  | 0.042 |
| 1.91           | 0.371 | 0.2230 | -0.042 | -0.336 | 0.038  | 0.055 |
| 4.01           | 0.810 | 0.2540 | -0.064 | -0.687 | 0.054  | 0.072 |
| 6.30           | 1.338 | 0.3277 | -0.084 | -1.109 | 0.031  | 0.093 |
| 7.95           | 1.753 | 0.4200 | -0.117 | -1.454 | 0.036  | 0.162 |
| 10.27          | 2.454 | 0.6025 | -0.215 | -2.018 | 0.025  | 0.299 |
| 12.28          | 3.097 | 0.8051 | -0.356 | -2.553 | -0.048 | 0.489 |
| 13.85          | 3.584 | 0.9851 | -0.444 | -2.924 | -0.137 | 0.673 |
| 15.87          | 4.210 | 1.2746 | -0.589 | -3.438 | -0.362 | 1.012 |
| 18.04          | 4.857 | 1.6341 | -0.750 | -4.011 | -0.831 | 1.539 |
| 20.30          | 5.574 | 2.0687 | -0.980 | -4.527 | -1.665 | 2.414 |
| 22.03          | 6.172 | 2.4721 | -1.203 | -4.994 | -2.450 | 3.241 |
| 24.10          | 6.865 | 3.0020 | -1.495 | -5.516 | -3.616 | 4.313 |
| 26.01          | 7.466 | 3.5241 | -1.779 | -5.874 | -4.485 | 4.993 |
| 27.97          | 7.860 | 4.0089 | -2.104 | -5.955 | -4.762 | 5.119 |
| 29.57          | 8.162 | 4.4030 | -2.470 | -5.861 | -4.152 | 4.539 |

Figure B.49. Computer Tabulated Force and Moment Data for Missile I  
 11° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 11  
DATA TAKEN 11:37:30 14-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL     | CD     | CC     | CM     | CNW    | CLW   |
|----------------|--------|--------|--------|--------|--------|-------|
| -0.11          | 0.055  | 0.2413 | -0.062 | 0.056  | 0.001  | 0.000 |
| 1.81           | 0.429  | 0.2369 | -0.023 | -0.260 | 0.033  | 0.047 |
| 4.12           | 0.929  | 0.2727 | -0.041 | -0.686 | 0.032  | 0.067 |
| 6.14           | 1.421  | 0.3406 | -0.075 | -1.074 | 0.055  | 0.106 |
| 7.87           | 1.926  | 0.4404 | -0.101 | -1.489 | 0.070  | 0.146 |
| 10.27          | 2.744  | 0.6559 | -0.150 | -2.141 | 0.063  | 0.241 |
| 11.97          | 3.362  | 0.8618 | -0.204 | -2.588 | 0.021  | 0.353 |
| 14.11          | 4.095  | 1.1689 | -0.259 | -3.095 | -0.018 | 0.437 |
| 15.67          | 4.664  | 1.4339 | -0.330 | -3.466 | -0.122 | 0.582 |
| 18.01          | 5.565  | 1.9025 | -0.431 | -4.037 | -0.325 | 0.875 |
| 19.76          | 6.238  | 2.2978 | -0.527 | -4.413 | -0.544 | 1.163 |
| 21.85          | 7.130  | 2.8795 | -0.686 | -4.871 | -0.893 | 1.603 |
| 24.13          | 8.101  | 3.5788 | -0.888 | -5.341 | -1.390 | 2.273 |
| 26.20          | 8.988  | 4.3116 | -1.132 | -5.603 | -1.959 | 3.026 |
| 27.95          | 9.542  | 4.9054 | -1.368 | -5.690 | -2.352 | 3.677 |
| 29.63          | 10.031 | 5.5195 | -1.622 | -5.574 | -2.834 | 4.342 |

Figure B.50. Computer Tabulated Force and Moment Data for Missile I  
33° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 12  
DATA TAKEN 09:08:42 15-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW    | CLW   |
|----------------|-------|--------|--------|--------|--------|-------|
| -0.03          | 0.004 | 0.2139 | -0.025 | 0.025  | 0.014  | 0.014 |
| 1.90           | 0.347 | 0.2148 | -0.027 | -0.269 | 0.014  | 0.012 |
| 4.07           | 0.762 | 0.2333 | -0.040 | -0.653 | 0.038  | 0.031 |
| 6.04           | 1.180 | 0.2907 | -0.061 | -1.067 | 0.067  | 0.061 |
| 7.93           | 1.632 | 0.3749 | -0.102 | -1.542 | 0.097  | 0.104 |
| 10.25          | 2.273 | 0.5364 | -0.180 | -2.177 | 0.117  | 0.197 |
| 11.66          | 2.685 | 0.6660 | -0.233 | -2.599 | 0.074  | 0.288 |
| 13.73          | 3.261 | 0.8752 | -0.335 | -3.215 | -0.024 | 0.499 |
| 15.88          | 3.843 | 1.1306 | -0.443 | -3.812 | -0.223 | 0.803 |
| 17.76          | 4.365 | 1.4066 | -0.553 | -4.379 | -0.520 | 1.180 |
| 20.02          | 5.004 | 1.8089 | -0.706 | -5.078 | -1.082 | 1.809 |
| 21.77          | 5.480 | 2.1473 | -0.820 | -5.504 | -1.755 | 2.268 |
| 23.83          | 6.035 | 2.5712 | -0.970 | -5.957 | -2.655 | 2.961 |
| 26.20          | 6.515 | 3.0612 | -1.183 | -6.231 | -3.565 | 3.532 |
| 27.69          | 6.757 | 3.3604 | -1.306 | -6.376 | -3.969 | 3.549 |
| 29.58          | 7.130 | 3.8017 | -1.541 | -6.592 | -3.818 | 3.147 |

Figure B.51. Computer Tabulated Force and Moment Data for Missile II  
11° Roll, Fin No. 1, Blunt Nose



RUN NUMBER IS 13  
DATA TAKEN 09:42:20 15 JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW    | CLW    |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.33          | 0.050 | 0.2230 | -0.078 | 0.181  | 0.055  | -0.056 |
| 2.07           | 0.321 | 0.2236 | -0.042 | -0.210 | 0.055  | 0.061  |
| 4.01           | 0.894 | 0.2562 | -0.058 | -0.579 | 0.080  | 0.077  |
| 6.11           | 1.375 | 0.3268 | -0.080 | -1.094 | 0.126  | 0.121  |
| 8.10           | 1.906 | 0.4373 | -0.127 | -1.618 | 0.159  | 0.169  |
| 10.26          | 2.353 | 0.6108 | -0.207 | -2.287 | 0.194  | 0.246  |
| 11.70          | 3.030 | 0.7646 | -0.258 | -2.746 | 0.159  | 0.327  |
| 13.88          | 3.764 | 1.0414 | -0.358 | -3.431 | 0.108  | 0.502  |
| 15.69          | 4.381 | 1.3152 | -0.459 | -3.983 | 0.037  | 0.735  |
| 17.84          | 5.102 | 1.6987 | -0.571 | -4.538 | -0.189 | 1.055  |
| 19.80          | 5.785 | 2.1048 | -0.719 | -5.027 | -0.475 | 1.469  |
| 22.13          | 6.725 | 2.7059 | -0.945 | -5.696 | -0.999 | 2.198  |
| 24.11          | 7.489 | 3.2717 | -1.160 | -6.202 | -1.649 | 2.972  |
| 26.06          | 8.235 | 3.9154 | -1.411 | -6.635 | -2.451 | 3.859  |
| 28.22          | 8.827 | 4.5893 | -1.737 | -6.633 | -3.086 | 4.555  |
| 29.58          | 9.064 | 4.9690 | -1.919 | -6.348 | -3.356 | 4.838  |

Figure B.52. Computer Tabulated Force and Moment Data for Missile II  
33° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 14  
DATA TAKEN 15:19:23 15-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | Cl    | C <sub>D</sub> | C <sub>C</sub> | C <sub>M</sub> | C <sub>NW</sub> | C <sub>LW</sub> |
|----------------|-------|----------------|----------------|----------------|-----------------|-----------------|
| 0.27           | 0.040 | 0.2150         | -0.007         | -0.066         | 0.004           | 0.004           |
| 1.74           | 0.287 | 0.2168         | -0.023         | -0.312         | 0.009           | 0.014           |
| 4.12           | 0.713 | 0.2440         | -0.034         | -0.743         | 0.042           | 0.048           |
| 6.01           | 1.057 | 0.2871         | -0.037         | -1.158         | 0.054           | 0.077           |
| 8.01           | 1.533 | 0.3732         | -0.073         | -1.676         | 0.091           | 0.137           |
| 9.82           | 1.978 | 0.4835         | -0.115         | -2.252         | 0.173           | 0.204           |
| 11.95          | 2.537 | 0.6525         | -0.151         | -2.952         | 0.246           | 0.268           |
| 13.73          | 2.974 | 0.8253         | -0.188         | -3.525         | 0.324           | 0.341           |
| 15.94          | 3.528 | 1.0623         | -0.251         | -4.247         | 0.248           | 0.442           |
| 18.27          | 4.108 | 1.3683         | -0.316         | -4.985         | 0.242           | 0.615           |
| 20.00          | 4.533 | 1.6350         | -0.385         | -5.561         | 0.155           | 0.826           |
| 21.74          | 4.976 | 1.9446         | -0.493         | -6.189         | -0.094          | 1.209           |
| 23.92          | 5.515 | 2.3679         | -0.594         | -6.876         | -0.389          | 1.502           |
| 26.21          | 5.814 | 2.7717         | -0.668         | -7.109         | 0.254           | 0.865           |
| 27.65          | 6.076 | 3.0394         | -0.695         | -7.397         | 0.427           | 0.738           |
| 29.56          | 6.380 | 3.4370         | -0.791         | -7.754         | 0.632           | 0.716           |

Figure B.53. Computer Tabulated Force and Moment Data for Missile III  
11° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 15  
DATA TAKEN 15:33:49 15-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL     | CD     | CC     | CM     | CNW    | CLW    |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.23          | -0.001 | 0.2173 | -0.009 | 0.052  | -0.045 | -0.046 |
| 1.87           | 0.371  | 0.2191 | -0.022 | -0.301 | 0.009  | 0.019  |
| 3.98           | 0.748  | 0.2481 | -0.039 | -0.713 | 0.013  | 0.034  |
| 6.13           | 1.207  | 0.3047 | -0.056 | -1.213 | 0.063  | 0.100  |
| 7.95           | 1.600  | 0.3893 | -0.106 | -1.706 | 0.104  | 0.177  |
| 9.72           | 2.103  | 0.5042 | -0.150 | -2.332 | 0.207  | 0.237  |
| 11.89          | 2.728  | 0.7009 | -0.237 | -3.196 | 0.329  | 0.433  |
| 13.84          | 3.306  | 0.9126 | -0.320 | -3.995 | 0.385  | 0.660  |
| 15.86          | 3.886  | 1.1798 | -0.419 | -4.784 | 0.427  | 0.837  |
| 18.07          | 4.476  | 1.4877 | -0.499 | -5.487 | 0.431  | 0.955  |
| 19.79          | 5.017  | 1.8121 | -0.605 | -6.050 | 0.301  | 1.295  |
| 22.18          | 5.724  | 2.3033 | -0.794 | -6.792 | 0.102  | 1.790  |
| 24.05          | 6.239  | 2.7302 | -0.998 | -7.174 | 0.073  | 2.125  |
| 26.14          | 6.711  | 3.2293 | -1.164 | -7.409 | 0.024  | 2.271  |
| 28.21          | 7.313  | 3.7910 | -1.327 | -7.867 | -0.714 | 2.806  |
| 29.65          | 7.637  | 4.1767 | -1.452 | -7.994 | -1.252 | 3.149  |

Figure B.54. Computer Tabulated Force and Moment Data for Missile III  
33° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 16  
DATA TAKEN 11:05:29 18-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW    | CLW    |
|----------------|-------|--------|--------|--------|--------|--------|
| -0.04          | 0.015 | 0.1941 | -0.001 | -0.037 | -0.006 | -0.006 |
| 1.09           | 0.273 | 0.1899 | -0.005 | -0.336 | 0.001  | -0.005 |
| 4.23           | 0.635 | 0.2096 | -0.017 | -0.719 | 0.032  | 0.018  |
| 6.08           | 0.947 | 0.2508 | -0.036 | -1.127 | 0.056  | 0.057  |
| 7.99           | 1.232 | 0.3102 | -0.049 | -1.651 | 0.092  | 0.091  |
| 9.86           | 1.680 | 0.4128 | -0.075 | -2.161 | 0.146  | 0.113  |
| 11.63          | 2.094 | 0.5305 | -0.111 | -2.743 | 0.229  | 0.142  |
| 13.82          | 2.470 | 0.6872 | -0.148 | -3.525 | 0.261  | 0.224  |
| 15.98          | 2.996 | 0.9003 | -0.198 | -4.296 | 0.426  | 0.249  |
| 17.89          | 3.363 | 1.0951 | -0.228 | -4.968 | 0.525  | 0.211  |
| 19.71          | 3.781 | 1.3336 | -0.238 | -5.600 | 0.554  | 0.194  |
| 21.87          | 4.274 | 1.6722 | -0.274 | -6.432 | 0.597  | 0.237  |
| 24.09          | 4.780 | 2.0582 | -0.324 | -7.234 | 0.638  | 0.248  |
| 26.19          | 5.037 | 2.3851 | -0.283 | -7.512 | 1.003  | -0.285 |
| 27.85          | 5.082 | 2.5893 | -0.273 | -7.405 | 2.365  | -1.445 |
| 29.72          | 5.290 | 2.8848 | -0.384 | -7.628 | 2.665  | -1.487 |

Figure B.55. Computer Tabulated Force and Moment Data for Missile IV  
11° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 17  
 DATA TAKEN 11:27:41 18-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW    | CIW    |
|----------------|-------|--------|--------|--------|--------|--------|
| 0.22           | 0.079 | 0.2060 | -0.081 | -0.051 | 0.022  | 0.023  |
| 1.79           | 0.348 | 0.1778 | -0.021 | -0.395 | -0.003 | -0.001 |
| 4.13           | 0.683 | 0.2197 | -0.025 | -0.714 | 0.022  | 0.016  |
| 5.93           | 0.979 | 0.2537 | -0.044 | -1.099 | 0.055  | 0.040  |
| 7.73           | 1.261 | 0.3114 | -0.067 | -1.590 | 0.097  | 0.082  |
| 9.72           | 1.811 | 0.4381 | -0.109 | -2.273 | 0.175  | 0.158  |
| 11.71          | 2.196 | 0.5561 | -0.164 | -2.976 | 0.241  | 0.221  |
| 13.94          | 2.741 | 0.7495 | -0.221 | -3.813 | 0.361  | 0.313  |
| 15.85          | 3.194 | 0.9440 | -0.290 | -4.696 | 0.512  | 0.391  |
| 17.89          | 3.657 | 1.1892 | -0.336 | -5.501 | 0.538  | 0.508  |
| 19.92          | 4.196 | 1.4938 | -0.354 | -6.318 | 0.804  | 0.470  |
| 21.88          | 4.657 | 1.8230 | -0.476 | -7.139 | 1.069  | 0.464  |
| 24.11          | 5.084 | 2.2181 | -0.541 | -7.816 | 1.444  | 0.254  |
| 25.87          | 5.177 | 2.4551 | -0.522 | -7.720 | 3.016  | -1.262 |
| 27.67          | 5.402 | 2.7339 | -0.577 | -8.151 | 3.332  | -1.425 |
| 29.58          | 5.726 | 3.1197 | -0.647 | -8.405 | 3.418  | -1.384 |

Figure B.56. Computer Tabulated Force and Moment Data for Missile IV  
 33° Roll, Fin No. 1, Blunt Nose

RUN NUMBER IS 18  
 DATA TAKEN 11:10:23 15-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW   | CLW   |
|----------------|-------|--------|--------|--------|-------|-------|
| 0.13           | 0.033 | 0.2191 | -0.018 | -0.063 | 0.004 | 0.004 |
| 1.75           | 0.320 | 0.2188 | -0.026 | -0.317 | 0.009 | 0.016 |
| 3.96           | 0.703 | 0.2350 | -0.040 | -0.697 | 0.027 | 0.048 |
| 5.91           | 1.118 | 0.2855 | -0.055 | -1.130 | 0.050 | 0.088 |
| 7.97           | 1.553 | 0.3670 | -0.076 | -1.619 | 0.092 | 0.151 |
| 9.71           | 1.980 | 0.4743 | -0.131 | -2.129 | 0.151 | 0.210 |
| 11.77          | 2.557 | 0.6409 | -0.183 | -2.809 | 0.177 | 0.277 |
| 13.98          | 3.118 | 0.8822 | -0.230 | -3.433 | 0.082 | 0.414 |
| 15.70          | 3.569 | 1.0491 | -0.284 | -3.974 | 0.092 | 0.525 |
| 18.00          | 4.114 | 1.3461 | -0.362 | -4.653 | 0.041 | 0.703 |
| 19.88          | 4.609 | 1.6413 | -0.418 | -5.213 | 0.056 | 0.962 |
| 21.79          | 5.114 | 1.9827 | -0.524 | -5.847 | 0.032 | 1.278 |
| 23.76          | 5.618 | 2.3846 | -0.600 | -6.384 | 0.115 | 1.533 |
| 26.15          | 5.961 | 2.8120 | -0.615 | -6.573 | 0.809 | 0.774 |
| 27.63          | 6.212 | 3.1025 | -0.620 | -6.768 | 1.161 | 0.442 |
| 29.58          | 6.507 | 3.4964 | -0.713 | -6.926 | 1.003 | 0.776 |

Figure B.57. Computer Tabulated Force and Moment Data for Missile III  
 11° Roll, Fin No. 1, Pointed Nose

RUN NUMBER IS 19  
DATA TAKEN 11:30:38 15-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL     | CD     | CC     | CM     | CNW    | CLW    |
|----------------|--------|--------|--------|--------|--------|--------|
| -0.37          | -0.007 | 0.2374 | -0.033 | 0.085  | -0.049 | -0.052 |
| 1.92           | 0.434  | 0.2340 | -0.053 | -0.287 | 0.015  | 0.031  |
| 4.01           | 0.798  | 0.2627 | -0.054 | -0.654 | 0.024  | 0.060  |
| 6.01           | 1.224  | 0.3086 | -0.077 | -1.129 | 0.075  | 0.128  |
| 7.71           | 1.600  | 0.3774 | -0.099 | -1.568 | 0.125  | 0.191  |
| 10.26          | 2.284  | 0.5441 | -0.171 | -2.407 | 0.236  | 0.297  |
| 11.65          | 2.722  | 0.6787 | -0.239 | -2.896 | 0.261  | 0.421  |
| 13.77          | 3.329  | 0.9037 | -0.347 | -3.601 | 0.283  | 0.684  |
| 15.72          | 3.938  | 1.1786 | -0.450 | -4.274 | 0.290  | 0.916  |
| 17.67          | 4.524  | 1.4897 | -0.571 | -4.896 | 0.182  | 1.224  |
| 20.00          | 5.213  | 1.9112 | -0.723 | -5.566 | 0.076  | 1.587  |
| 21.74          | 5.745  | 2.2759 | -0.871 | -6.056 | -0.022 | 2.013  |
| 24.08          | 6.480  | 2.8363 | -1.100 | -6.502 | 0.080  | 2.450  |
| 25.98          | 7.112  | 3.3813 | -1.359 | -6.878 | -0.570 | 3.243  |
| 28.03          | 7.519  | 3.8757 | -1.726 | -6.761 | -0.677 | 3.574  |
| 29.51          | 7.797  | 4.2563 | -1.929 | -6.523 | -0.410 | 3.498  |

Figure B.58. Computer Tabulated Force and Moment Data for Missile III  
33° Roll, Fin No. 1, Pointed Nose

RUN NUMBER IS 20  
DATA TAKEN 15:08:41 14-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | Cl    | Cd     | Ce     | Cm     | Cnw   | Clw    |
|----------------|-------|--------|--------|--------|-------|--------|
| 0.26           | 0.035 | 0.2311 | -0.019 | -0.095 | 0.006 | 0.006  |
| 2.09           | 0.418 | 0.2398 | -0.018 | -0.562 | 0.012 | 0.020  |
| 3.99           | 0.801 | 0.2499 | -0.035 | -1.077 | 0.031 | 0.039  |
| 6.14           | 1.260 | 0.3252 | -0.046 | -1.692 | 0.032 | 0.047  |
| 7.98           | 1.760 | 0.4190 | -0.085 | -2.369 | 0.079 | 0.137  |
| 9.73           | 2.238 | 0.5336 | -0.115 | -3.023 | 0.116 | 0.219  |
| 11.72          | 2.778 | 0.7023 | -0.170 | -3.782 | 0.186 | 0.308  |
| 13.75          | 3.283 | 0.8974 | -0.204 | -4.486 | 0.261 | 0.390  |
| 15.98          | 3.852 | 1.1559 | -0.301 | -5.242 | 0.505 | 0.502  |
| 17.89          | 4.248 | 1.3921 | -0.401 | -5.788 | 0.706 | 0.671  |
| 19.73          | 4.667 | 1.6567 | -0.497 | -6.358 | 0.879 | 0.778  |
| 21.68          | 5.142 | 1.9854 | -0.589 | -6.969 | 0.980 | 0.737  |
| 23.77          | 5.582 | 2.3676 | -0.516 | -7.427 | 1.145 | -0.031 |
| 25.99          | 5.963 | 2.7803 | -0.510 | -7.803 | 1.444 | -0.782 |
| 27.92          | 6.202 | 3.0992 | -0.604 | -7.971 | 1.800 | -1.328 |
| 29.65          | 6.486 | 3.4447 | -0.679 | -8.285 | 2.064 | -1.540 |

Figure B.59. Computer Tabulated Force and Moment Data for Missile III  
11° Roll, Fin No. 2, Blunt Nose



RUN NUMBER IS 21  
DATA TAKEN 16:16:18 14-JAN-87

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | Cl    | CD     | CC     | CM     | CNW   | CLW   |
|----------------|-------|--------|--------|--------|-------|-------|
| 0.26           | 0.045 | 0.2376 | -0.073 | -0.026 | 0.018 | 0.019 |
| 1.95           | 0.448 | 0.2450 | -0.031 | -0.476 | 0.007 | 0.021 |
| 4.05           | 0.881 | 0.2754 | -0.037 | -1.036 | 0.015 | 0.041 |
| 6.01           | 1.293 | 0.3368 | -0.065 | -1.639 | 0.051 | 0.092 |
| 8.11           | 1.866 | 0.4531 | -0.110 | -2.471 | 0.120 | 0.185 |
| 9.71           | 2.319 | 0.5665 | -0.153 | -3.115 | 0.204 | 0.265 |
| 11.78          | 2.910 | 0.7531 | -0.222 | -3.982 | 0.354 | 0.395 |
| 13.69          | 3.450 | 0.9525 | -0.395 | -4.710 | 0.462 | 0.481 |
| 15.82          | 4.045 | 1.2266 | -0.364 | -5.531 | 0.625 | 0.515 |
| 17.91          | 4.589 | 1.5277 | -0.459 | -6.247 | 0.964 | 0.452 |
| 20.18          | 5.279 | 1.9379 | -0.601 | -6.985 | 1.195 | 0.446 |
| 22.23          | 5.916 | 2.3740 | -0.806 | -7.769 | 1.163 | 0.903 |
| 24.08          | 6.452 | 2.8214 | -1.008 | -8.349 | 1.364 | 1.170 |
| 26.28          | 6.962 | 3.3457 | -1.222 | -8.683 | 1.855 | 0.919 |
| 27.99          | 7.287 | 3.7520 | -1.294 | -8.758 | 2.121 | 0.573 |
| 29.47          | 7.532 | 4.0885 | -1.397 | -8.620 | 2.120 | 0.312 |

Figure No. B.60. Computer Tabulated Force and Moment Data for Missile III  
33° Roll, Fin No. 2, Blunt Nose

RUN NUMBER IS 22  
DATA TAKEN 08146:48 15-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW   | CLW    |
|----------------|-------|--------|--------|--------|-------|--------|
| 0.17           | 0.111 | 0.2156 | -0.050 | -0.025 | 0.011 | 0.012  |
| 1.97           | 0.474 | 0.2285 | -0.038 | -0.476 | 0.011 | 0.015  |
| 4.20           | 0.951 | 0.2727 | -0.042 | -1.047 | 0.014 | 0.032  |
| 6.07           | 1.347 | 0.3217 | -0.054 | -1.619 | 0.030 | 0.035  |
| 7.95           | 1.833 | 0.4121 | -0.106 | -2.275 | 0.075 | 0.139  |
| 10.32          | 2.478 | 0.5852 | -0.136 | -3.137 | 0.122 | 0.219  |
| 11.97          | 2.942 | 0.7373 | -0.184 | -3.715 | 0.129 | 0.298  |
| 13.93          | 3.426 | 0.9333 | -0.242 | -4.371 | 0.141 | 0.396  |
| 16.06          | 3.914 | 1.1804 | -0.344 | -5.024 | 0.296 | 0.587  |
| 17.90          | 4.345 | 1.4206 | -0.398 | -5.542 | 0.525 | 0.656  |
| 19.70          | 4.762 | 1.6883 | -0.507 | -6.058 | 0.799 | 0.767  |
| 21.86          | 5.263 | 2.0428 | -0.551 | -6.671 | 1.028 | 0.674  |
| 24.15          | 5.697 | 2.4653 | -0.389 | -7.026 | 1.541 | -0.460 |
| 26.25          | 6.030 | 2.8362 | -0.364 | -7.264 | 1.943 | -1.436 |
| 27.86          | 6.243 | 3.1216 | -0.325 | -7.383 | 2.170 | -1.795 |
| 29.66          | 6.428 | 3.4496 | -0.408 | -7.500 | 2.507 | -2.061 |

Figure B.61. Computer Tabulated Force and Moment Data for Missile III  
11° Roll Fin No. 2, Pointed Nose

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permit fully legible reproduction

RUN NUMBER IS 23  
DATA TAKEN 08129:16 15-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | Cl    | Cd     | Ce     | Cm     | Cnw    | Clw    |
|----------------|-------|--------|--------|--------|--------|--------|
| 0.20           | 0.023 | 0.2274 | -0.002 | -0.073 | -0.023 | -0.022 |
| 1.97           | 0.372 | 0.2330 | -0.012 | -0.524 | -0.014 | -0.009 |
| 4.09           | 0.813 | 0.2667 | -0.009 | -1.095 | -0.007 | 0.011  |
| 6.27           | 1.318 | 0.3340 | -0.039 | -1.767 | 0.044  | 0.073  |
| 8.24           | 1.830 | 0.4408 | -0.094 | -2.530 | 0.121  | 0.148  |
| 9.94           | 2.346 | 0.5648 | -0.147 | -3.230 | 0.207  | 0.230  |
| 11.94          | 2.901 | 0.7460 | -0.225 | -3.979 | 0.326  | 0.367  |
| 14.04          | 3.484 | 0.9648 | -0.308 | -4.698 | 0.417  | 0.489  |
| 15.73          | 3.997 | 1.2010 | -0.398 | -5.332 | 0.682  | 0.516  |
| 17.76          | 4.538 | 1.5003 | -0.500 | -5.904 | 0.907  | 0.529  |
| 19.81          | 5.154 | 1.8746 | -0.617 | -6.543 | 1.015  | 0.621  |
| 21.91          | 5.809 | 2.3177 | -0.797 | -7.262 | 1.200  | 0.861  |
| 24.16          | 6.508 | 2.8516 | -1.089 | -7.977 | 1.455  | 1.362  |
| 26.30          | 6.996 | 3.3491 | -1.261 | -8.055 | 2.096  | 0.937  |
| 28.03          | 7.267 | 3.7114 | -1.395 | -7.838 | 2.756  | 0.232  |
| 29.70          | 7.762 | 4.2429 | -1.457 | -7.964 | 3.363  | 0.204  |

Figure B.62. Computer Tabulated Force and Moment Data for Missile III  
33° Roll, Fin No. 2, Pointed Nose

RUN NUMBER IS 24  
 DATA TAKEN 16:08:04 15-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL     | CD     | CC     | CM     | CNW    | CIW   |
|----------------|--------|--------|--------|--------|--------|-------|
| -0.16          | -0.008 | 0.2508 | -0.012 | -0.031 | 0.018  | 0.018 |
| 1.89           | 0.333  | 0.2460 | -0.035 | -0.260 | 0.032  | 0.033 |
| 3.99           | 0.737  | 0.2735 | -0.025 | -0.562 | 0.035  | 0.049 |
| 6.02           | 1.154  | 0.3302 | -0.040 | -0.965 | 0.050  | 0.055 |
| 7.77           | 1.611  | 0.4148 | -0.069 | -1.427 | 0.109  | 0.104 |
| 9.65           | 2.162  | 0.5470 | -0.107 | -2.042 | 0.172  | 0.149 |
| 11.68          | 2.806  | 0.7420 | -0.163 | -2.797 | 0.234  | 0.273 |
| 14.32          | 3.582  | 1.0433 | -0.242 | -3.718 | 0.282  | 0.411 |
| 15.93          | 4.035  | 1.2589 | -0.294 | -4.244 | 0.288  | 0.517 |
| 17.86          | 4.616  | 1.5580 | -0.374 | -4.934 | 0.271  | 0.638 |
| 19.68          | 5.141  | 1.8811 | -0.444 | -5.550 | 0.152  | 0.892 |
| 21.99          | 5.817  | 2.3741 | -0.584 | -6.398 | -0.202 | 1.383 |
| 24.11          | 6.406  | 2.8479 | -0.582 | -7.034 | -0.452 | 1.260 |
| 26.19          | 6.920  | 3.3305 | -0.627 | -7.663 | -0.609 | 1.323 |
| 27.88          | 7.287  | 3.7399 | -0.854 | -8.121 | -0.893 | 2.352 |
| 29.68          | 7.562  | 4.1746 | -1.115 | -8.459 | -1.340 | 3.290 |

Figure B.63. Computer Tabulated Force and Moment Data for Missile III  
 11° Roll, Fin No. 3, Blunt Nose

RUN NUMBER IS 25  
DATA TAKEN 08:25:28 18-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW    | CLW   |
|----------------|-------|--------|--------|--------|--------|-------|
| 0.11           | 0.042 | 0.2367 | -0.012 | -0.053 | 0.010  | 0.010 |
| 2.12           | 0.401 | 0.2439 | -0.002 | -0.295 | 0.018  | 0.023 |
| 4.18           | 0.798 | 0.2777 | -0.039 | -0.622 | 0.043  | 0.052 |
| 5.97           | 1.206 | 0.3346 | -0.041 | -1.001 | 0.077  | 0.082 |
| 7.91           | 1.723 | 0.4322 | -0.107 | -1.580 | 0.163  | 0.149 |
| 9.82           | 2.341 | 0.5907 | -0.177 | -2.330 | 0.285  | 0.293 |
| 11.92          | 3.076 | 0.8107 | -0.267 | -3.189 | 0.368  | 0.464 |
| 14.02          | 3.747 | 1.0731 | -0.360 | -4.010 | 0.439  | 0.630 |
| 15.94          | 4.404 | 1.3695 | -0.460 | -4.811 | 0.510  | 0.776 |
| 17.75          | 4.972 | 1.6744 | -0.564 | -5.517 | 0.576  | 0.970 |
| 19.80          | 5.716 | 2.1107 | -0.695 | -6.341 | 0.659  | 1.207 |
| 21.78          | 6.431 | 2.6019 | -0.833 | -7.086 | 0.293  | 1.764 |
| 23.86          | 7.076 | 3.1458 | -0.905 | -7.570 | -0.075 | 1.861 |
| 25.77          | 7.673 | 3.6668 | -1.040 | -8.050 | -0.415 | 2.300 |
| 27.96          | 8.202 | 4.2707 | -1.163 | -8.400 | -0.793 | 2.611 |
| 29.70          | 8.575 | 4.7780 | -1.164 | -8.520 | -1.750 | 3.069 |

Figure B.64. Computer Tabulated Force and Moment Data for Missile III  
33° Roll, Fin No. 3, Blunt Nose

RUN NUMBER IS 24  
DATA TAKEN 09109156 18-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW    | CLW   |
|----------------|-------|--------|--------|--------|--------|-------|
| 0.27           | 0.078 | 0.2339 | -0.054 | -0.073 | 0.059  | 0.059 |
| 2.08           | 0.423 | 0.2308 | -0.049 | -0.270 | 0.055  | 0.057 |
| 4.04           | 0.758 | 0.2457 | -0.054 | -0.543 | 0.064  | 0.072 |
| 5.93           | 1.184 | 0.3228 | -0.057 | -0.711 | 0.069  | 0.084 |
| 7.98           | 1.715 | 0.4214 | -0.081 | -1.446 | 0.135  | 0.125 |
| 9.77           | 2.247 | 0.5519 | -0.131 | -1.977 | 0.194  | 0.191 |
| 11.68          | 2.832 | 0.7398 | -0.190 | -2.666 | 0.222  | 0.286 |
| 14.01          | 3.513 | 1.0067 | -0.263 | -3.417 | 0.171  | 0.430 |
| 15.97          | 4.093 | 1.2781 | -0.340 | -4.069 | 0.142  | 0.599 |
| 18.00          | 4.671 | 1.5892 | -0.409 | -4.714 | 0.038  | 0.832 |
| 20.11          | 5.279 | 1.9757 | -0.501 | -5.411 | 0.127  | 1.021 |
| 21.69          | 5.737 | 2.3105 | -0.575 | -5.939 | -0.011 | 1.306 |
| 24.09          | 6.390 | 2.8488 | -0.563 | -6.594 | 0.001  | 1.072 |
| 25.79          | 6.792 | 3.2272 | -0.565 | -7.029 | 0.535  | 0.709 |
| 27.96          | 7.221 | 3.7385 | -0.802 | -7.474 | 0.507  | 1.580 |
| 29.48          | 7.529 | 4.1238 | -0.905 | -7.740 | 0.292  | 2.211 |

Figure B.65. Computer Tabulated Force and Moment Data for Missile III  
11° Roll, Fin No. 3, Pointed Nose

RUN NUMBER IS 27  
DATA TAKEN 08:47:51 18-JAN-82

## COEFFICIENTS ABOUT THE WIND AXIS

| ALPHA<br>(DEG) | CL    | CD     | CC     | CM     | CNW    | CLW   |
|----------------|-------|--------|--------|--------|--------|-------|
| 0.29           | 0.052 | 0.2403 | 0.001  | -0.091 | 0.005  | 0.006 |
| 1.96           | 0.377 | 0.2309 | -0.018 | -0.294 | 0.015  | 0.017 |
| 4.17           | 0.780 | 0.2647 | -0.025 | -0.628 | 0.036  | 0.041 |
| 6.08           | 1.212 | 0.3220 | -0.040 | -1.006 | 0.070  | 0.082 |
| 7.86           | 1.691 | 0.4156 | -0.094 | -1.544 | 0.156  | 0.159 |
| 9.89           | 2.364 | 0.5814 | -0.169 | -2.305 | 0.272  | 0.288 |
| 11.92          | 3.059 | 0.7949 | -0.261 | -3.085 | 0.340  | 0.446 |
| 14.06          | 3.744 | 1.0647 | -0.372 | -3.863 | 0.389  | 0.625 |
| 16.25          | 4.473 | 1.4060 | -0.489 | -4.658 | 0.357  | 0.878 |
| 18.28          | 5.200 | 1.7953 | -0.630 | -5.424 | 0.375  | 1.169 |
| 19.84          | 5.740 | 2.1288 | -0.742 | -5.933 | 0.226  | 1.512 |
| 21.91          | 6.455 | 2.6328 | -0.930 | -6.613 | -0.064 | 2.149 |
| 24.08          | 7.174 | 3.2046 | -1.015 | -7.032 | -0.381 | 2.352 |
| 25.72          | 7.735 | 3.6883 | -1.190 | -7.374 | -0.686 | 2.801 |
| 27.75          | 8.271 | 4.2725 | -1.317 | -7.604 | -1.423 | 3.473 |
| 29.70          | 8.781 | 4.8896 | -1.419 | -7.663 | -2.159 | 3.858 |

Figure B.66. Computer Tabulated Force and Moment Data for Missile III  
33° Roll, Fin No. 3, Pointed Nose

## Appendix C

### QUANTITATIVE FLOWFIELD MEASUREMENTS

Quantitative flowfield measurements were taken on the leeward side of both fineness ratio missiles (missiles of fineness ratio 8 and 16) using a 7-hole pressure probe described in section II-4. Tests were conducted in the subsonic wind tunnel at a freestream velocity of 100 fps. All tests were conducted of missiles without fins and with the blunt nose.

The flowfield pressure measurements were taken in measurement planes perpendicular to the axis of the tunnel on the leeward side of the missile as shown in Figure C.01. Each measurement plane was approximately 4.5 inches wide by 4.5 inches in height. Pressure probe measurements were taken every 0.25 inches in a grid pattern within the mapping plane. Approximately 400 data measurements were taken within each mapping plane.

Most of the pressure measurements were taken in the aft plane with respect to the missile as shown in Figure C.01. The aft plane was approximately 0.1 inches aft of the missile and extended approximately 0.4 inches below the upper surface of the missile, which is shown in Figure C.02. However, several pressure measurements were also taken in mapping planes along the length of the missile body. These mapping planes included areas



along the sides of the missile approximately 0.1 inches from the missile surface outward as shown in Figure C.02.

Table C-1 summarizes the flowfield tests conducted on the 4 different cross-section shaped missiles of fineness ratio equal to 8. The table illustrates the various missile orientations tested and the locations of the flowfield mapping planes in which pressure data was recorded. Data was taken in the aft mapping plane for missiles at 15, 20, and 25 degrees pitch and 0, 11, 22, 33, and 45 degrees roll. Data was taken in the 2/3 aft plane (approximately 8 inches behind the nose-body junction) for missiles at 25 degrees pitch and 0, 11, 22, 33 and 45 degrees roll. In addition, pressures were measured in planes 0, 2, 4, 6, 8, 10, and 12 inches aft of the nose-body junction for the 20% corner radius missile at 25 degrees pitch and 22 degrees roll.

Table C-2 summarizes the flowfield tests conducted on the 5 different cross-section shaped missiles of fineness ratio equal to 16. Pressure data was measured in the aft mapping plane for missiles at 30 degrees pitch and 0 and 22 degrees roll. In addition, data was taken in the aft plane for the 20% corner radius missile at 30 degrees pitch and 11, 33, and 45 degrees roll.

Once the raw pressure data was obtained at each measurement point in the plane, the data was then reduced to two components of

velocity (v and w) in the crossflow. The velocity crossflow measurements were plotted as a series of vectors originating at the respective points in the measurement grid, the length of each velocity vector being proportional to the magnitude of the crossflow velocity at that point. These plots were useful in visualizing vortices and their approximate locations relative to the missile. Velocity crossflow plots are shown in Figures C-1 through C-16 for the various missile configurations and orientations tested.

A nondimensional coefficient of total pressure,  $C_{Total}$ , was also calculated at each grid point and was the primary parameter used to analyze the flowfields.  $C_{Total}$  is the difference between the local total pressure ( $P_{oLocal}$ ) at the measurement point and the overall tunnel total pressure ( $P_{oTunnel}$ ) nondimensionalized by the tunnel dynamic pressure ( $P_{oTunnel} - P_{\infty Tunnel}$ ), where  $P_{\infty Tunnel}$  is the tunnel static pressure:

$$C_{Total} = \frac{P_{oLocal} - P_{oTunnel}}{P_{oTunnel} - P_{\infty Tunnel}}$$

$C_{Total}$  is negatively related to vortex strength, since a stronger vortex causes more viscous losses, resulting in a lower  $C_{Total}$ . Because a vortex is strongest at its center,  $C_{Total}$  will be most negative near the vortex center. Thus, by comparing  $C_{Total}$  measurements for various missile configurations, one can determine

which missile configurations have stronger vortices and the positions of these vortices relative to the missile body. A computer program was used to plot constant  $C_{Total}$  contours in each measurement plane. Figures C-1 through C-16 show these  $C_{Total}$  contours and the values of  $C_{Total}$  at the center of vortices in the measurement planes for the various missile configurations and orientations tested.

By comparing the crossflow velocity vectors and total pressure contours in Figures C-1 through C-16 for the various missile configurations and orientations tested, trends can be observed on how various parameters affect the flowfield. The data essentially illustrates how pitch angle, roll angle, body corner radius, nose shape, and fineness ratio affect the flowfield. In addition, the data (Figures 9 and 10) also illustrates how the flow changes along the axial length of the missile body. For a detailed analysis on how each of these parameters affect the flowfield, refer to references 9 and 10.

One final observation should be pointed out when comparing the flowfield data in Figures C-1 through C-16. Figures C-1 through C-8 and C-14 through C-16 are plotted looking upstream (view looking at aft end of missile). Figures C-9 through C-13 are plotted looking downstream (view looking at front of missile). Therefore, to compare, for example, Figures C-8 and C-13 one must take the mirror image of Figure C-8 and compare that to Figure C-13.

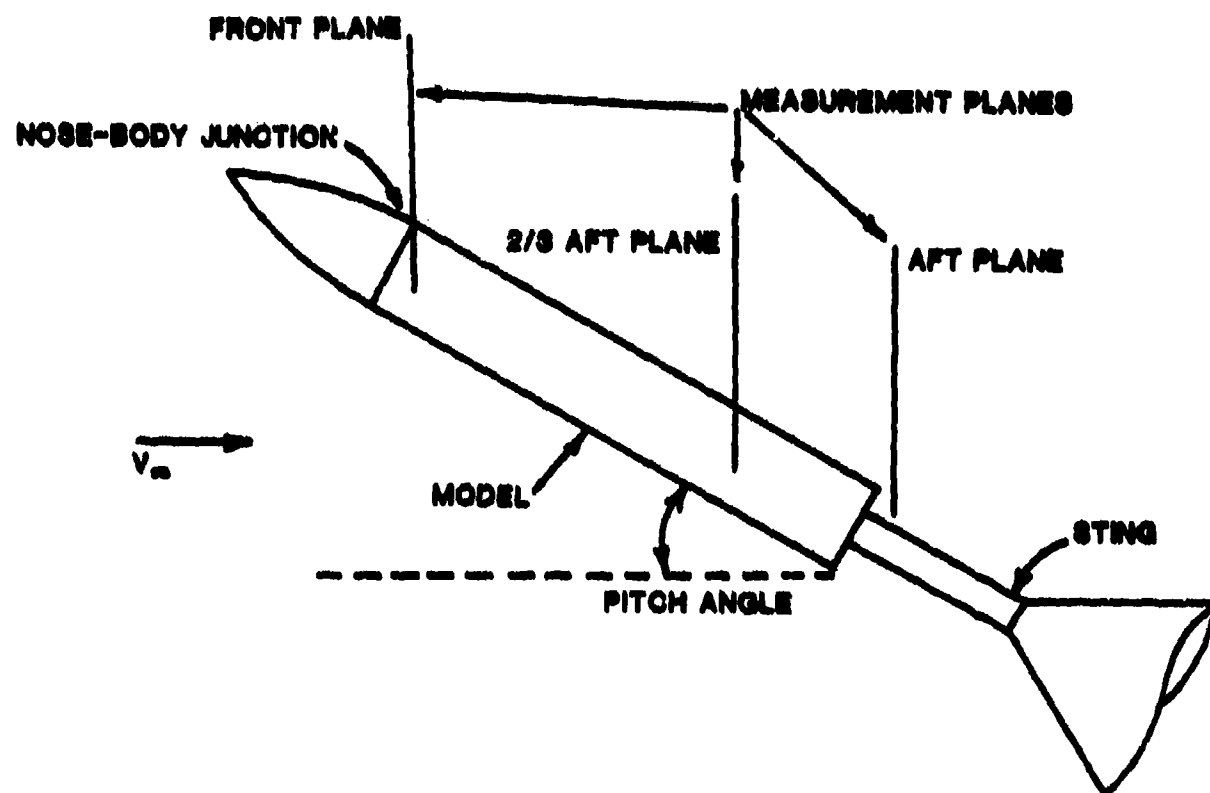


Figure C.01 Flowfield Measurement Planes

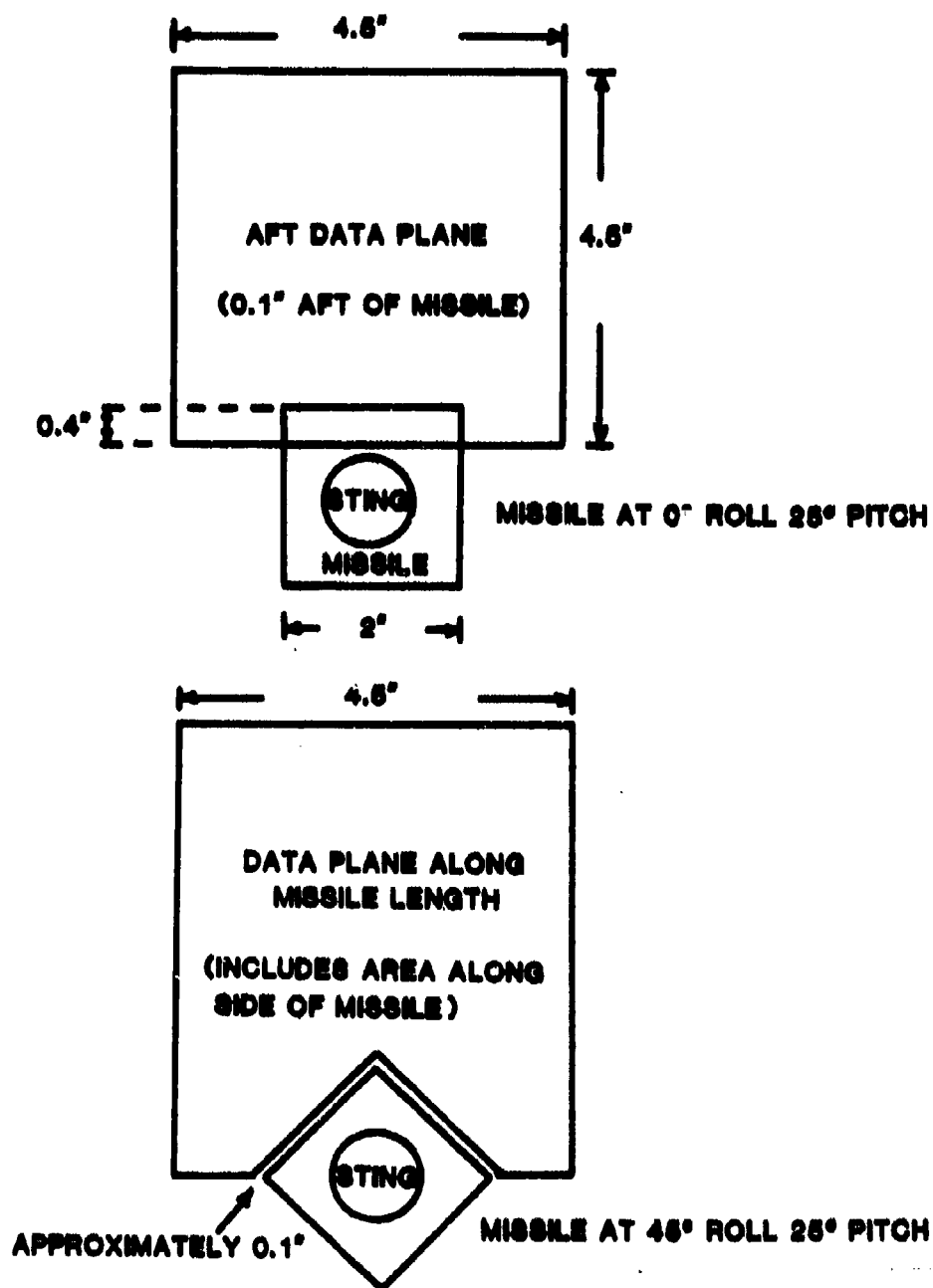


Figure C.02 Data Measurement Planes Aft of Missile and along Missile. View is Looking Upstream (at Aft End of Missile)

**TABLE C-1**  
**QUANTITATIVE FLOWFIELD TESTS**  
(Missiles of Fineness Ratio Equal to 8)

| MISSILE**<br>BODY     | ROLL<br>ANGLE            | ANGLE<br>OF<br>ATTACK | LOCATION***<br>OF DATA<br>PLANE                         | VIEW OF<br>DATA PLANE<br>(looking-) | FIGURE |
|-----------------------|--------------------------|-----------------------|---|-------------------------------------|--------|
| I, II, III            | 11° & 33°                | 15°                   | Aft of missile  | Upstream                            | C-1    |
| I, II, III, IV        | 9°                       | 20°                   | Aft of missile  | Upstream                            | C-2    |
| I, II, III            | 11° & 22°                | 20°                   | Aft of missile  | Upstream                            | C-3    |
| I, II, III            | 33° & 45°                | 20°                   | Aft of missile  | Upstream                            | C-4    |
| I, II, III, IIIP*, IV | 0°                       | 25°                   | Aft of missile  | Upstream                            | C-4    |
| I, II, III, IIIP*     | 22°                      | 25°                   | Aft of missile  | Upstream                            | C-6    |
| I, II, III, IIIP*     | 45°                      | 25°                   | Aft of missile  | Upstream                            | C-7    |
| I, II, III            | 11° & 33°                | 25°                   | Aft of missile  | Upstream                            | C-8    |
| I                     | 22°                      | 25°                   | 0, 2, 4, & 6 inches<br>aft of body-nose connection      | Downstream                          | C-9    |
| I                     | 22°                      | 25°                   | 8, 10, 12 inches<br>aft of body-nose connection         | Downstream                          | C-10   |
| I                     | 0°, 11°, 22°, 33° & 45°  | 25°                   | 8 inches aft of body-nose<br>connection (2/3 aft plane) | Downstream                          | C-11   |
| II                    | 0°, 11°, 22°, 33°, & 45° | 25°                   | 8 inches aft of body-nose<br>connection (2/3 aft plane) | Downstream                          | C-12   |
| III                   | 0°, 11°, 22°, 33°, & 45° | 25°                   | 8 inches aft of body-nose<br>connection (2/3 aft plane) | Downstream                          | C-13   |

\*Denotes body with pointed nose

\*\*Body Configurations

I - Square

II - 10% Corner Radius

III - 20% Corner Radius

IV - Round

\*\*\*See Figure C.01 for location of data planes.

TABLE C-2

## QUANTITATIVE FLOWFIELD TESTS

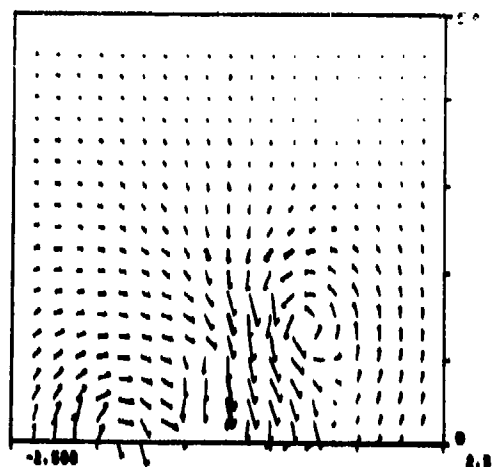
(Missiles of Fineness Ratio Equal to 16)

| MISSILE *<br>BODY | ROLL<br>ANGLE          | ANGLE<br>OF<br>ATTACK | LOCATION **<br>OF DATA<br>PLANE | VIEW OF<br>DATA PLANE<br>(LOOKING--) | FIGURE |
|-------------------|------------------------|-----------------------|---------------------------------|--------------------------------------|--------|
| 1,2,3,4,5         | 0°                     | 30°                   | Aft of Missile                  | Upstream                             | C-14   |
| 1,2,3,4,5         | 22°                    | 30°                   | Aft of Missile                  | Upstream                             | C-15   |
| 3                 | 0°, 11°, 22°, 33°, 45° | 30°                   | Aft of Missile                  | Upstream                             | C-16   |

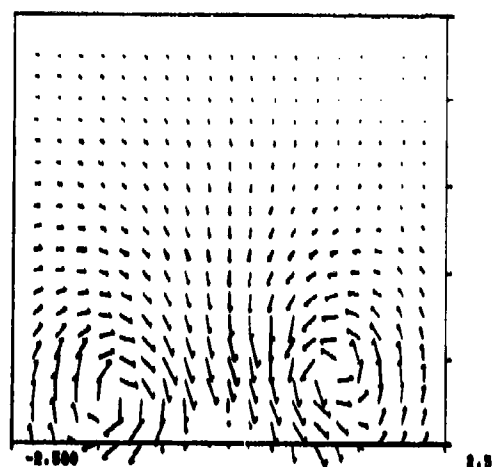
## \*Body Configurations

- 1 - Square
- 2 - 10% Corner Radius
- 3 - 20% Corner Radius
- 4 - 30% Corner Radius
- 5 - Round

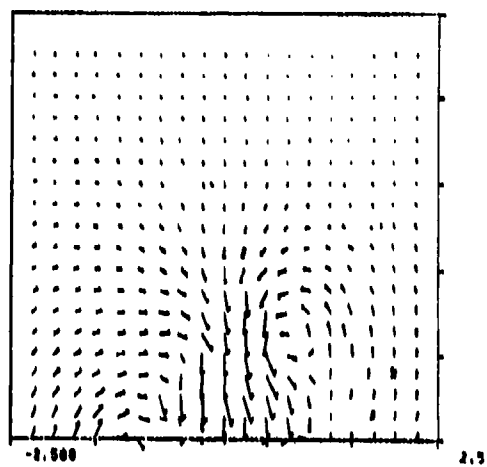
\*\*See Figure C.01 for location of aft data plane.



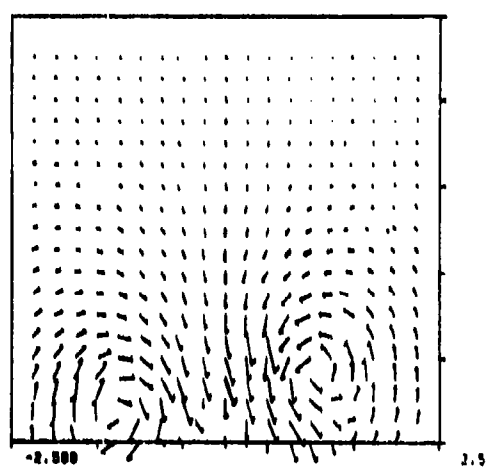
1A-1. MISSILE 1, 11 ROLL, 15 AOA.



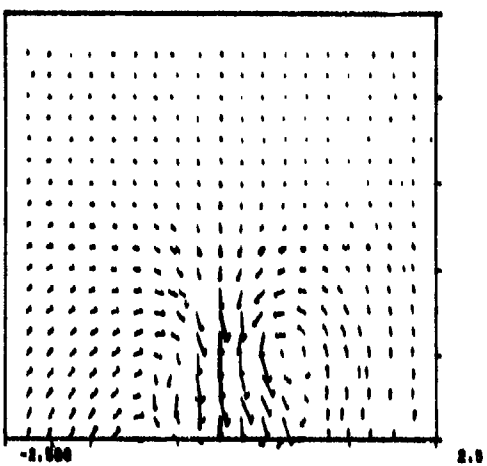
1A-4. MISSILE 1, 33 ROLL, 15 AOA.



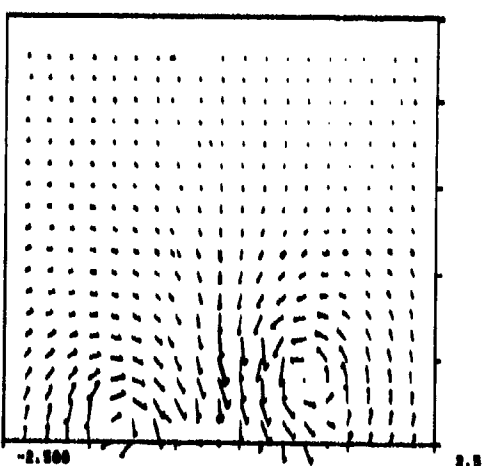
1A-2. MISSILE 11, 11 ROLL, 15 AOA.



1A-5. MISSILE 11, 33 ROLL, 15 AOA.



1A-3. MISSILE 111, 11 ROLL, 15 AOA.



1A-6. MISSILE 111, 33 ROLL, 15 AOA.

FIGURE C-1A. VELOCITY VECTOR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.



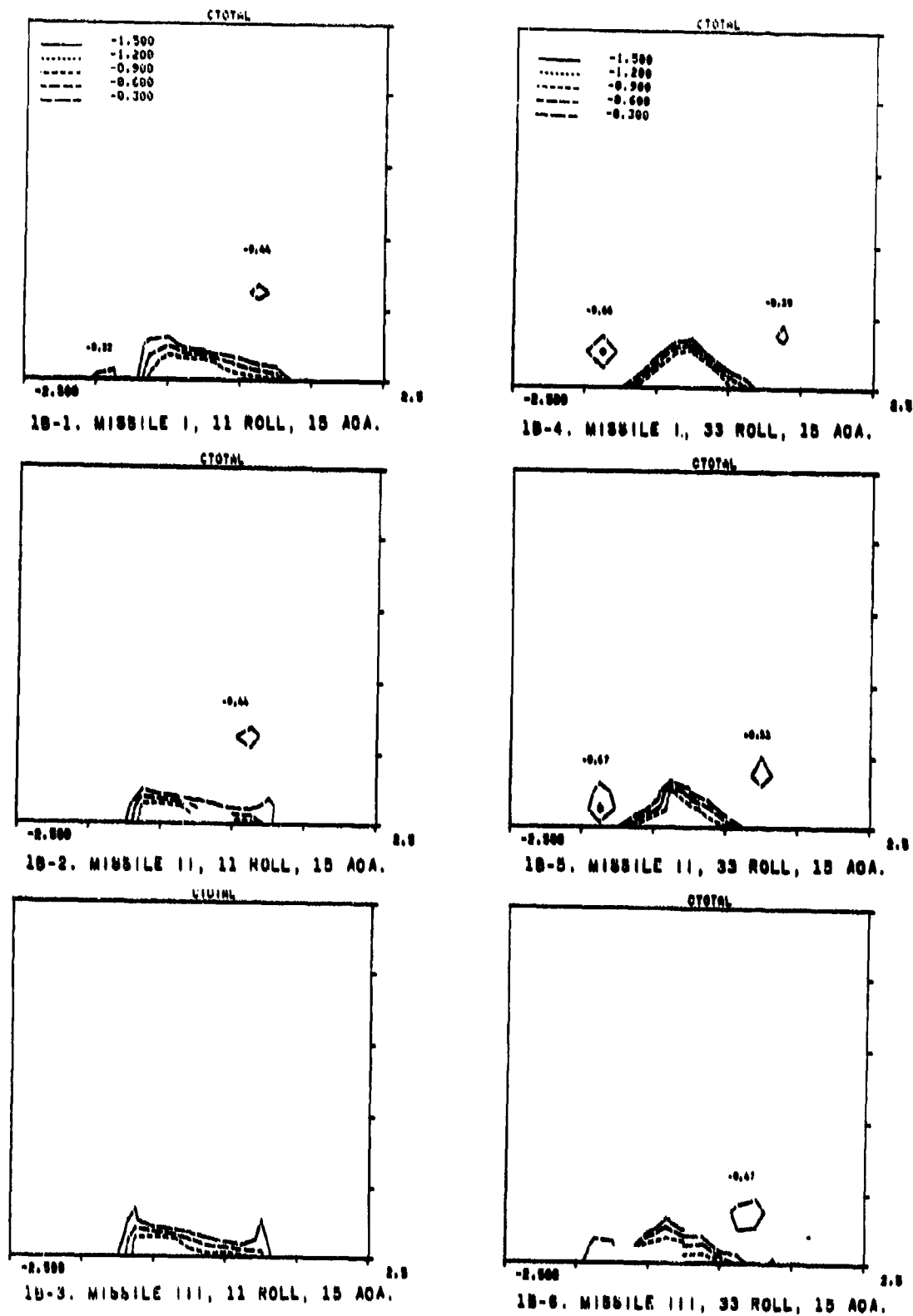


FIGURE C-1A. PRESSURE CONTOUR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.

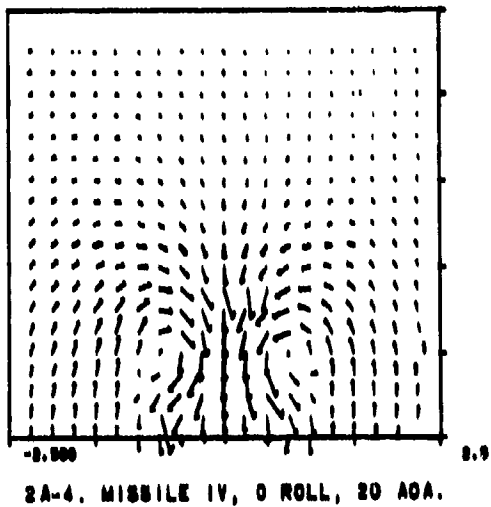
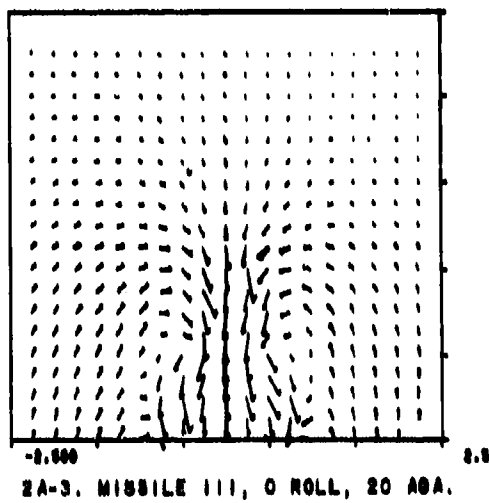
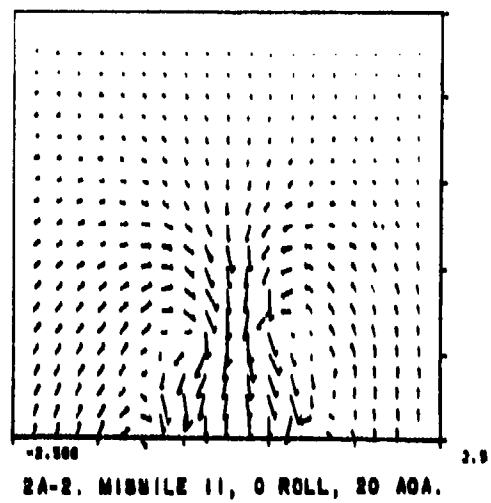
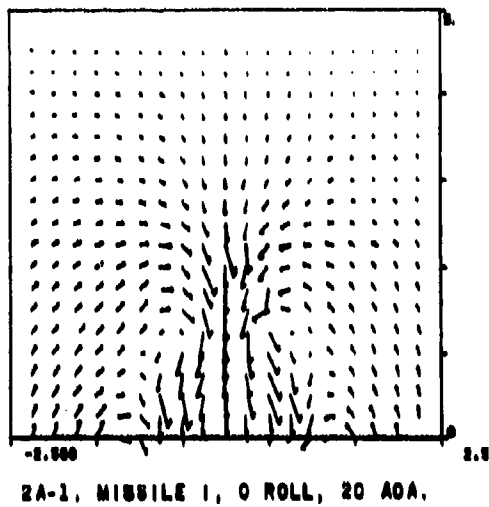
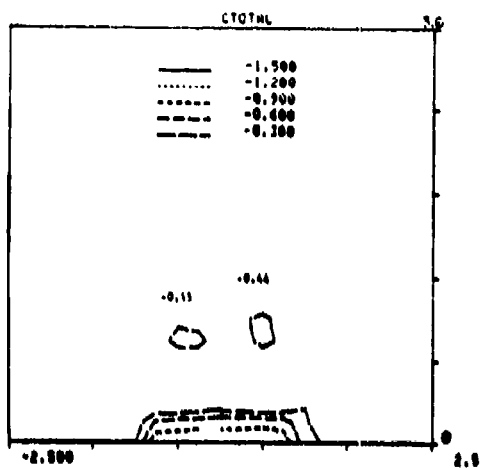
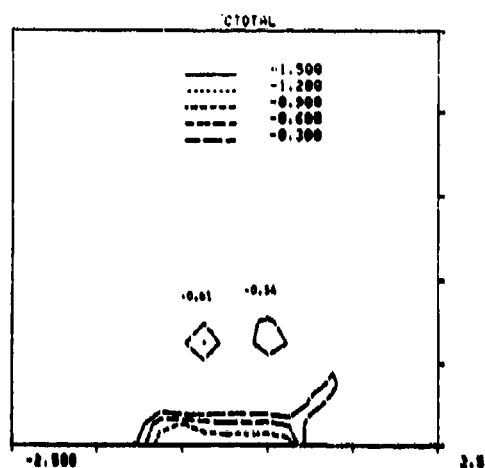


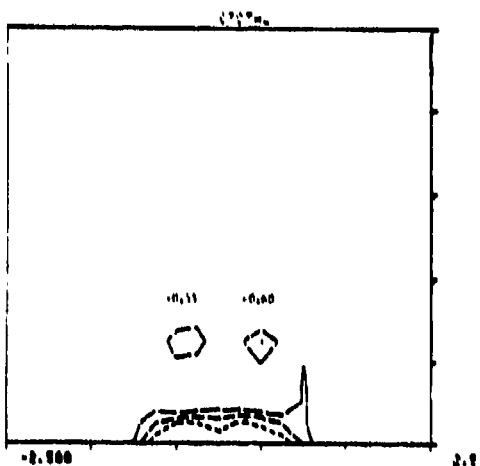
FIGURE C-2A. VELOCITY VECTOR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.



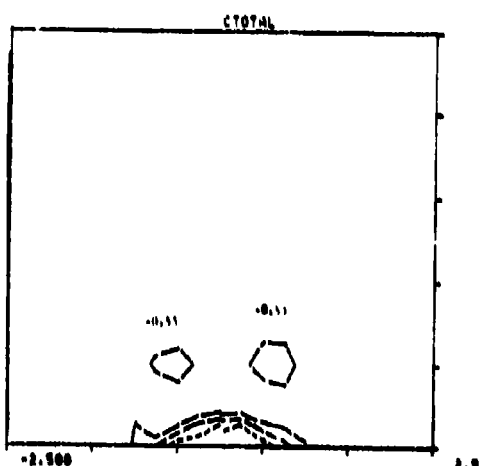
2B-1. MISSILE I, 0 ROLL, 20 AOA.



2B-2. MISSILE II, 0 ROLL, 20 AOA.

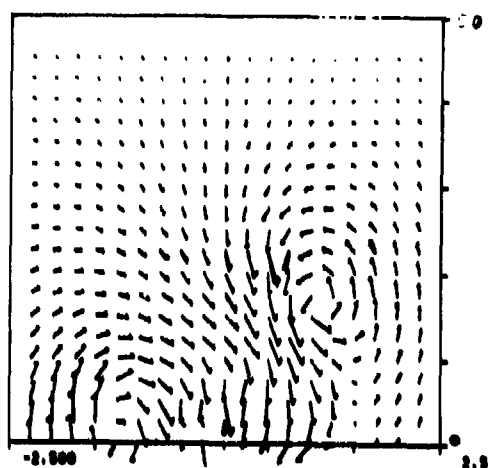


2B-3. MISSILE III, 0 ROLL, 20 AOA.

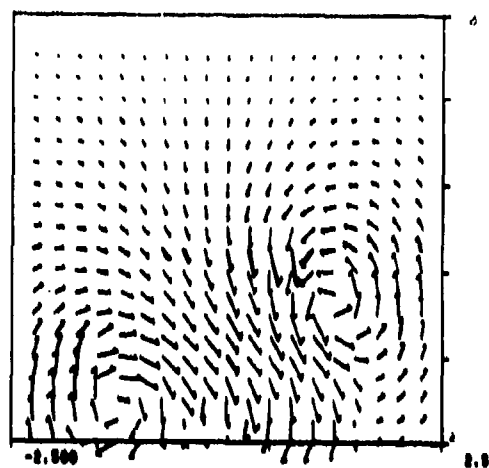


2B-4. MISSILE IV, 0 ROLL, 20 AOA.

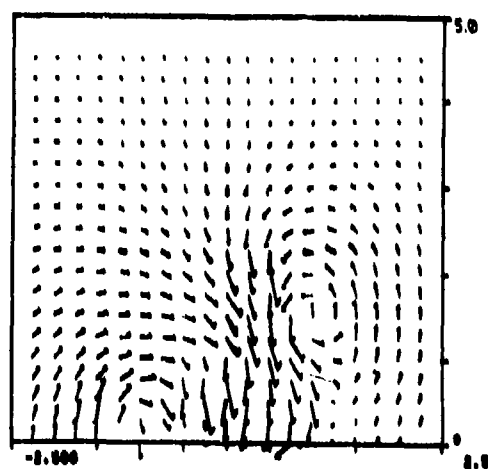
FIGURE C-2B. PRESSURE CONTOUR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.



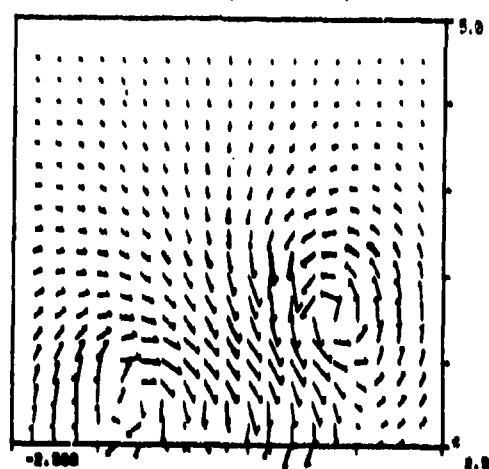
3A-1. MISSILE I, 11 ROLL, 20 AOA



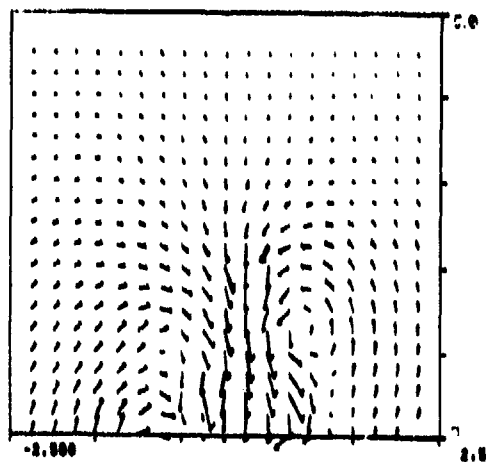
3A-4. MISSILE I, 22 ROLL, 20 AOA



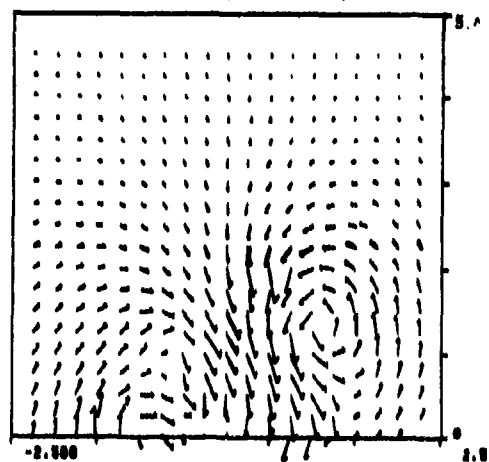
3A-2. MISSILE II, 11 ROLL, 20 AOA



3A-5. MISSILE II, 22 ROLL, 20 AOA

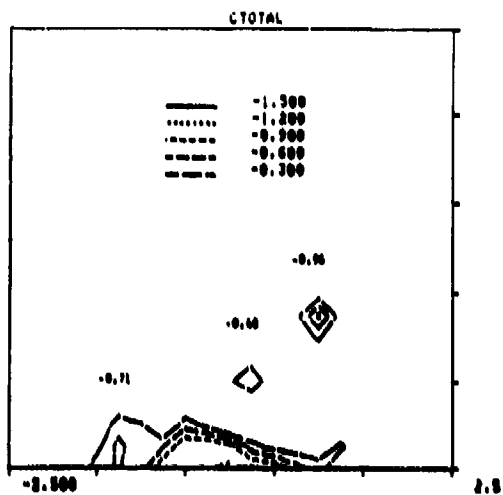


3A-3. MISSILE III, 11 ROLL, 20 AOA

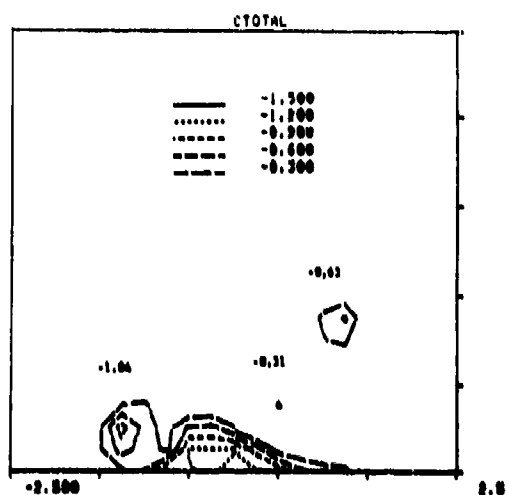


3A-6. MISSILE III, 22 ROLL, 20 AOA

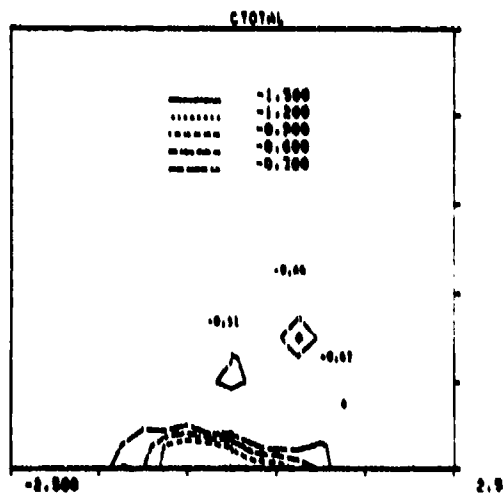
FIGURE C-3A. VELOCITY VECTOR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.



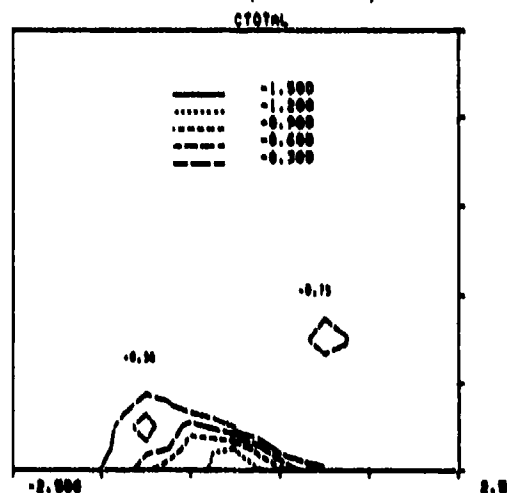
3A-1. MISSILE I, 11 ROLL, 20 AOA



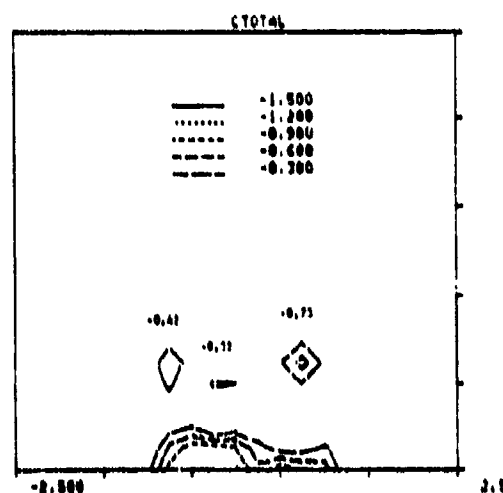
3B-4. MISSILE I, 22 ROLL, 20 AOA



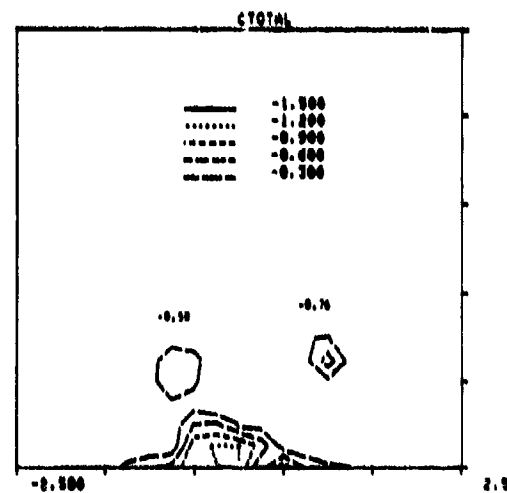
3B-2. MISSILE II, 11 ROLL, 20 AOA



3B-5. MISSILE II, 22 ROLL, 20 AOA

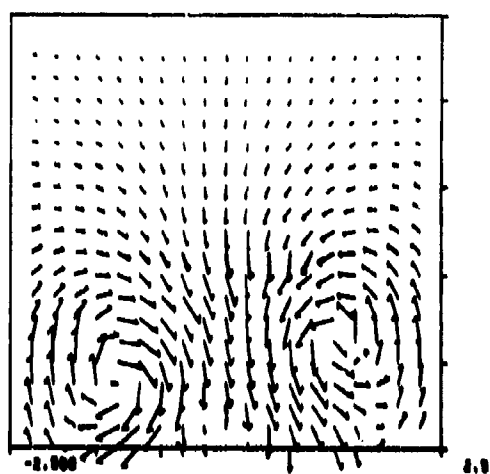


3B-3. MISSILE III, 11 ROLL, 20 AOA

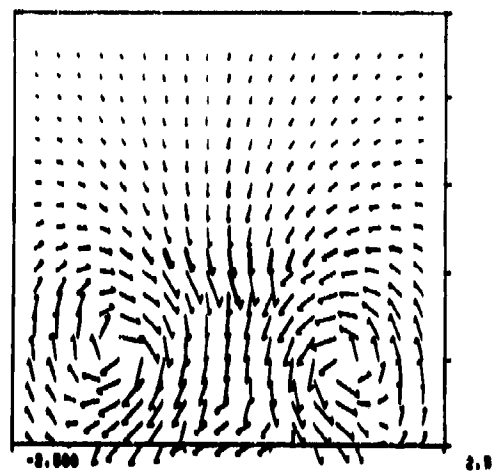


3B-6. MISSILE III, 22 ROLL, 20 AOA

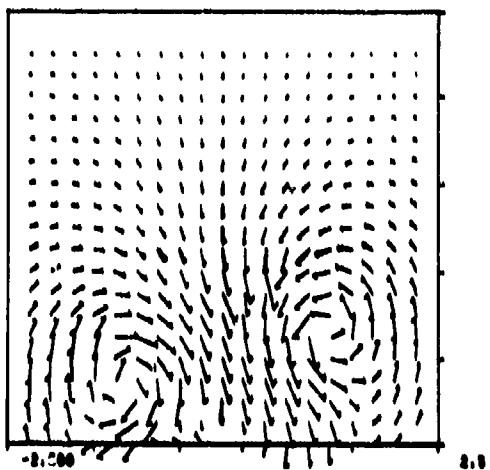
FIGURE C-3B. PRESSURE CONTOUR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.



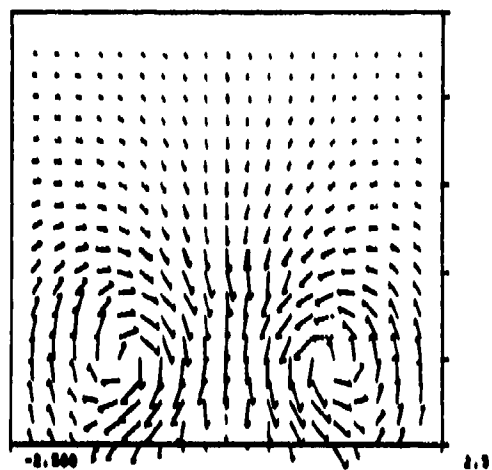
4A-1. MISSILE I, 33 ROLL, 20 AOA.



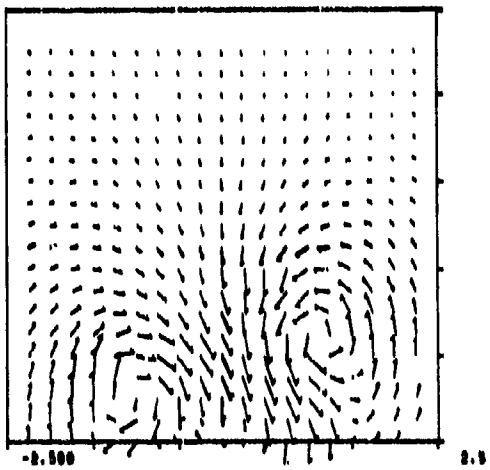
4A-4. MISSILE I, 45 ROLL, 20 AOA.



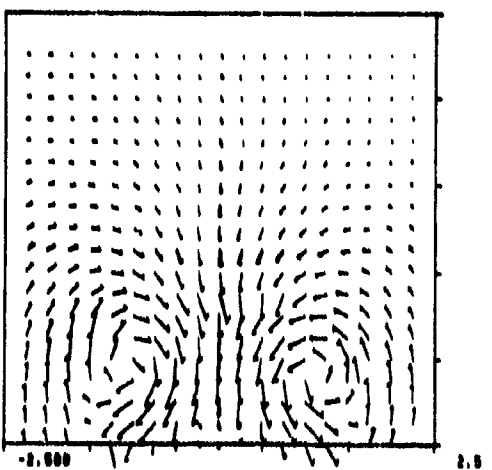
4A-2. MISSILE II, 33 ROLL, 20 AOA.



4A-5. MISSILE II, 45 ROLL, 20 AOA.



4A-3. MISSILE III, 33 ROLL, 20 AOA.



4A-6. MISSILE III, 45 ROLL, 20 AOA.

FIGURE C-4A. VELOCITY VECTOR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.

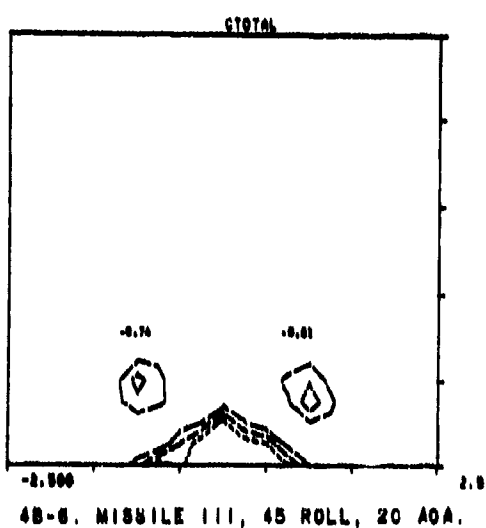
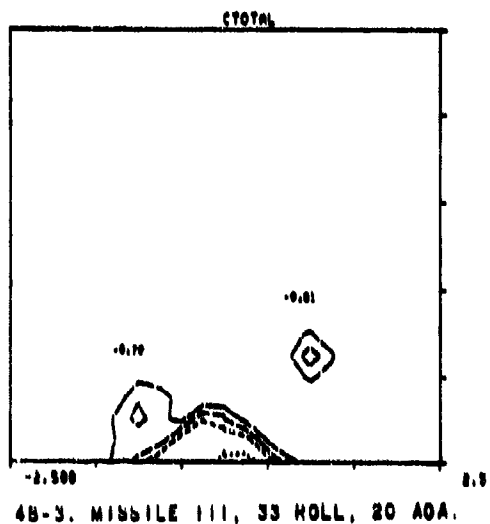
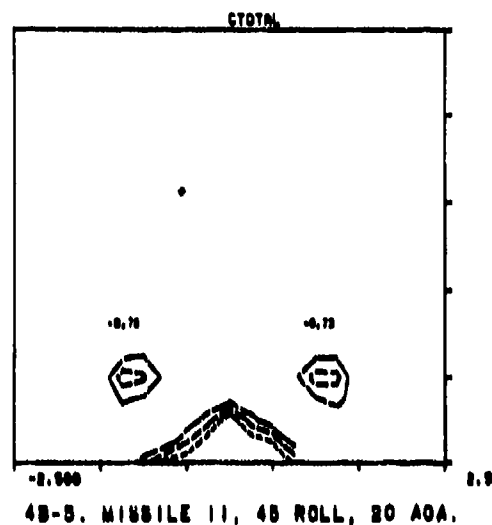
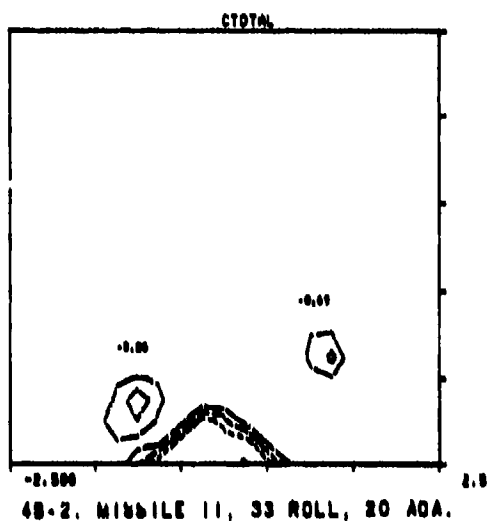
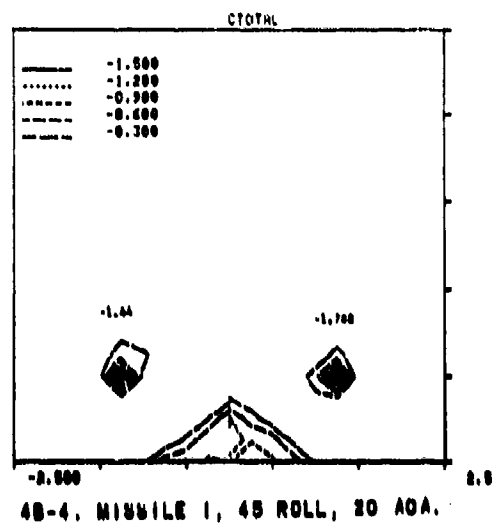
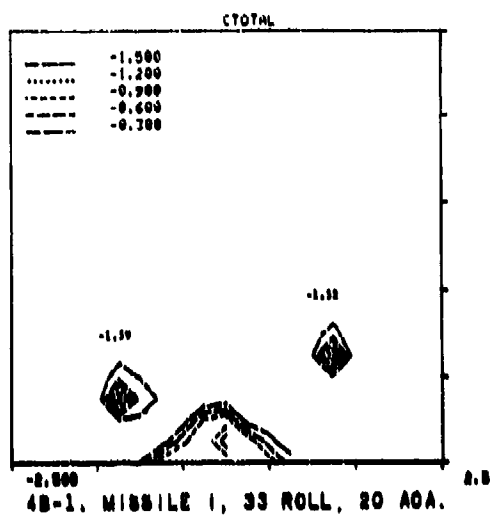


FIGURE C-4B. PRESSURE CONTOUR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.

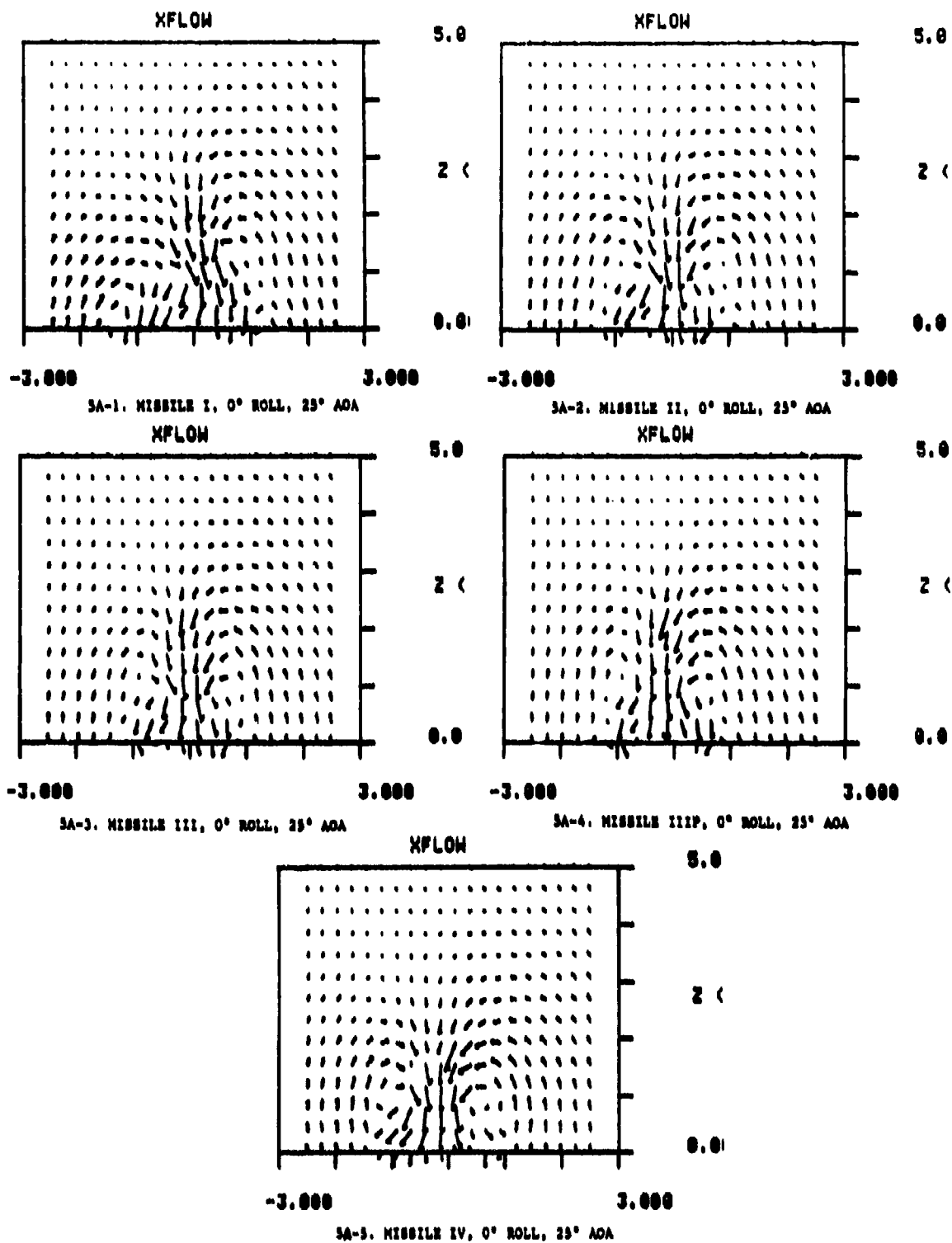


FIGURE C-5A. VELOCITY VECTOR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.



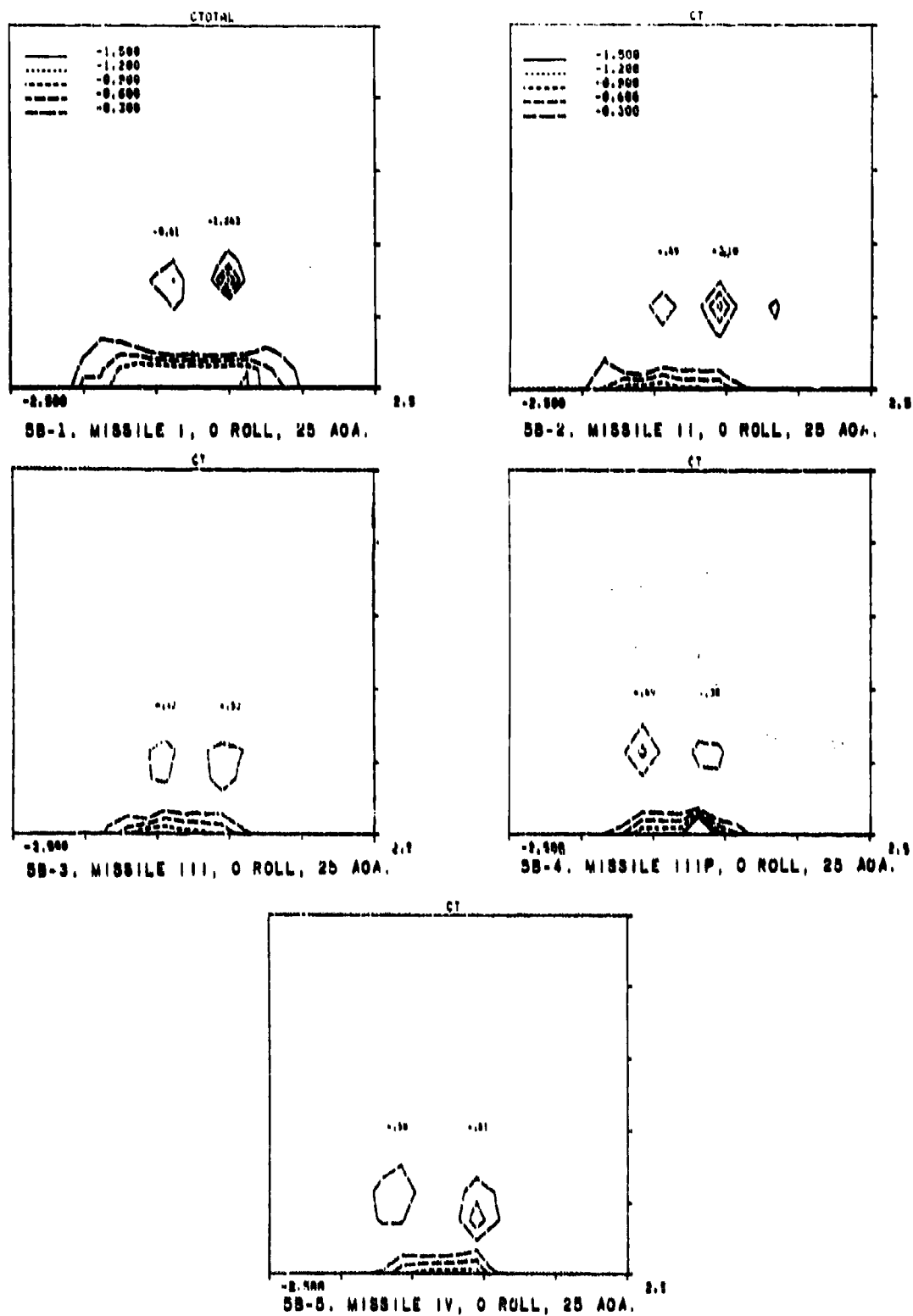
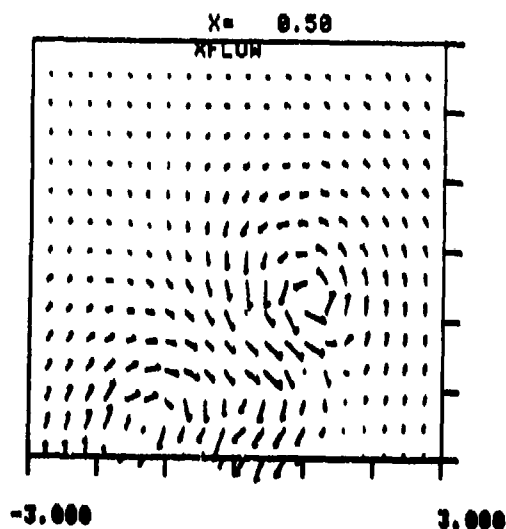
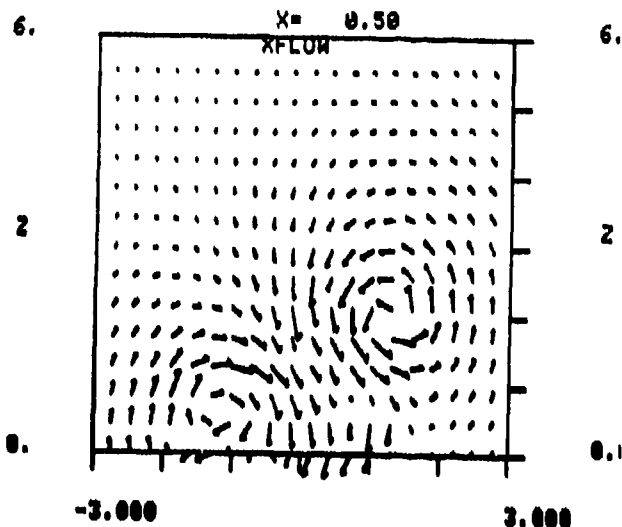


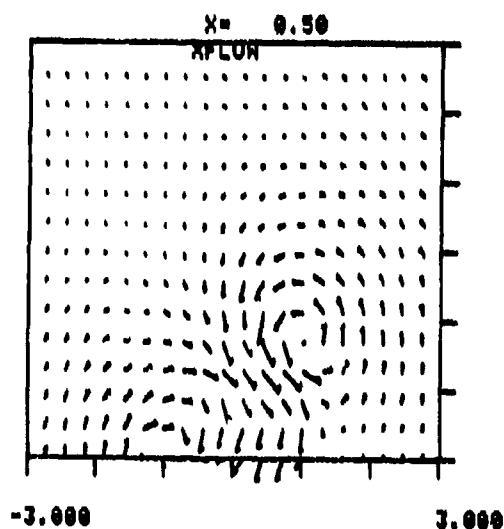
FIGURE C-5B. PRESSURE CONTOUR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.



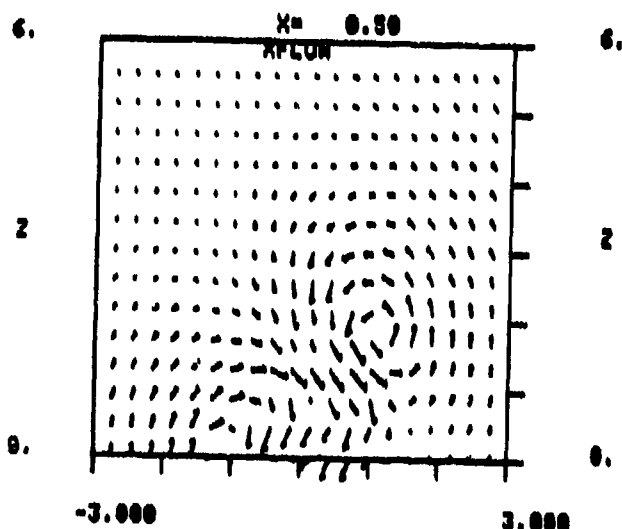
6A-1. MISSILE I, 22 ROLL, 25 AOA.



6A-2. MISSILE II, 22 ROLL, 25 AOA.



6A-3. MISSILE III, 22 ROLL, 25 AOA.



6A-4. MISSILE IIIP, 22 ROLL, 25 AOA.

FIGURE C-6A. VELOCITY VECTOR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.

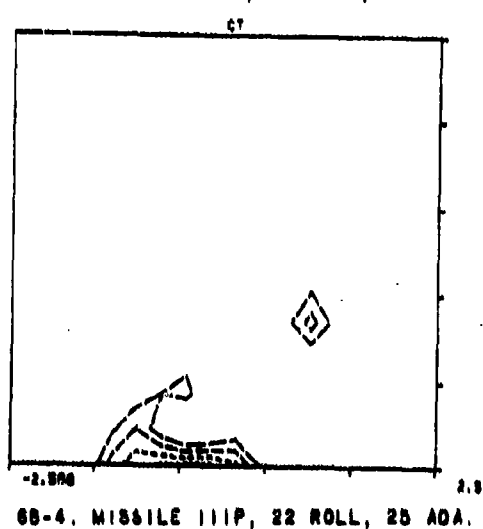
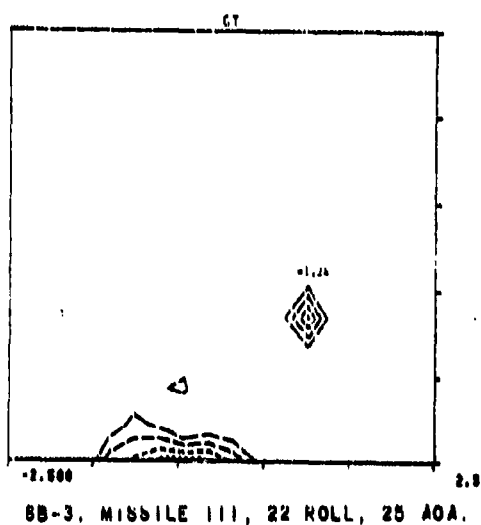
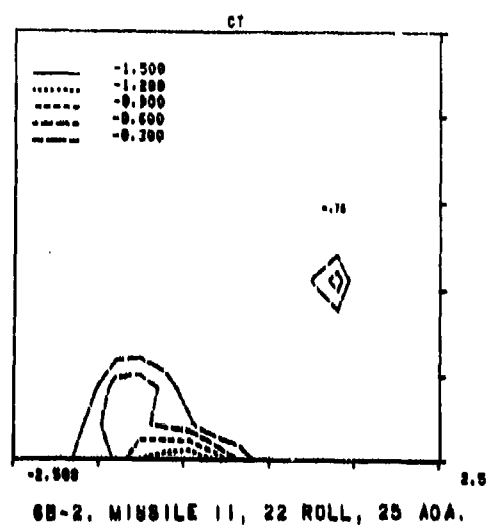
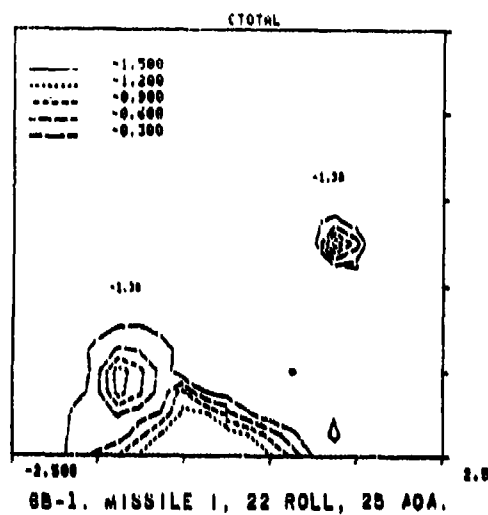


FIGURE C-6B. PRESSURE CONTOUR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.

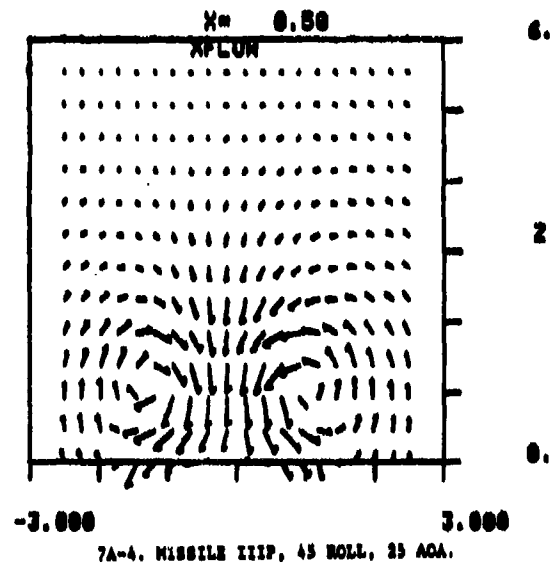
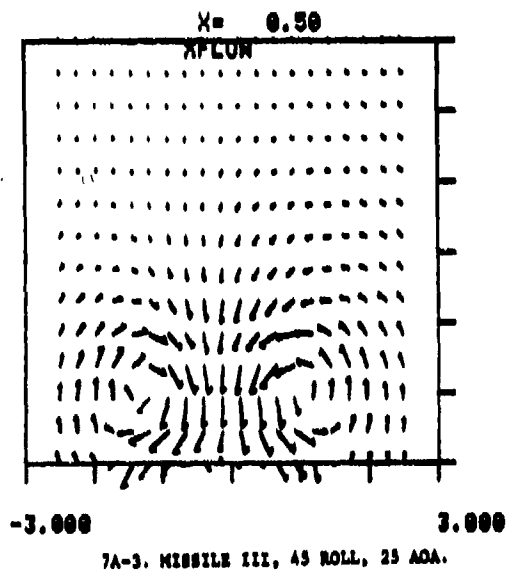
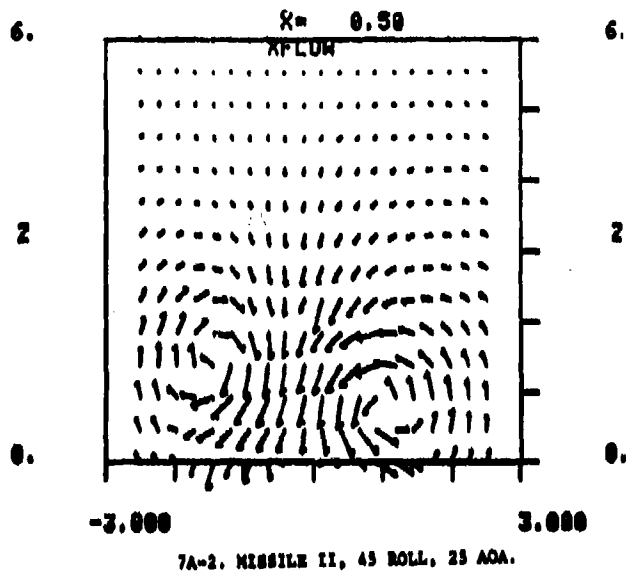
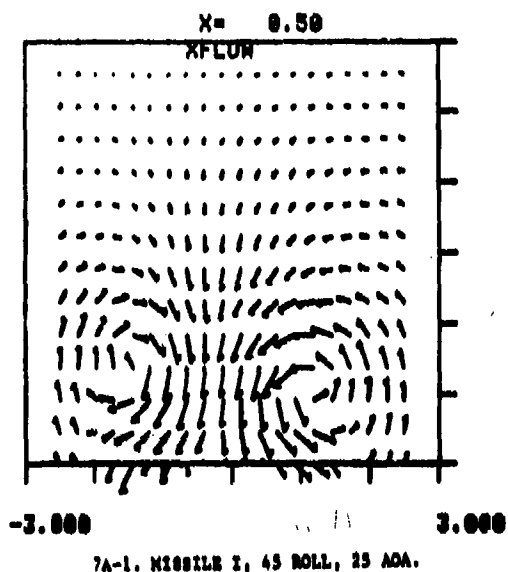


FIGURE C-7A. VELOCITY VECTOR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.

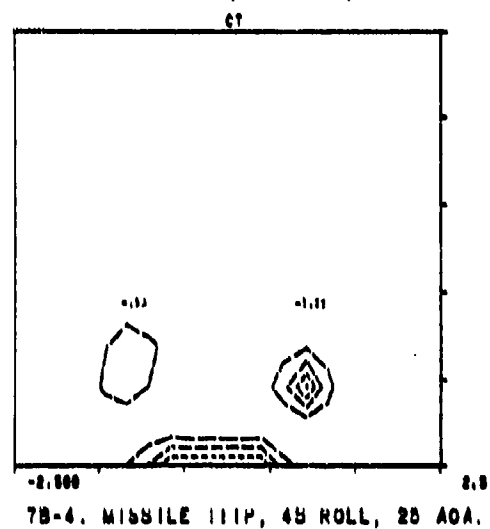
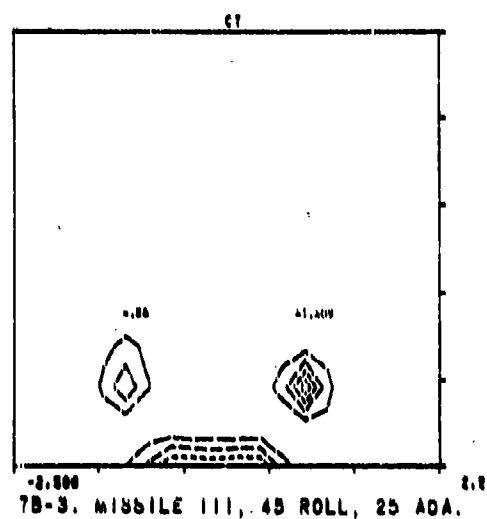
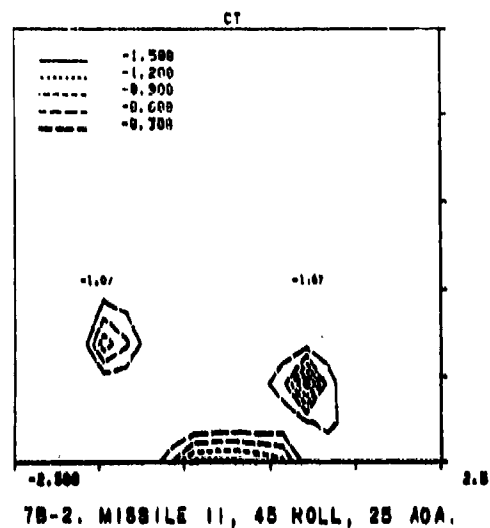
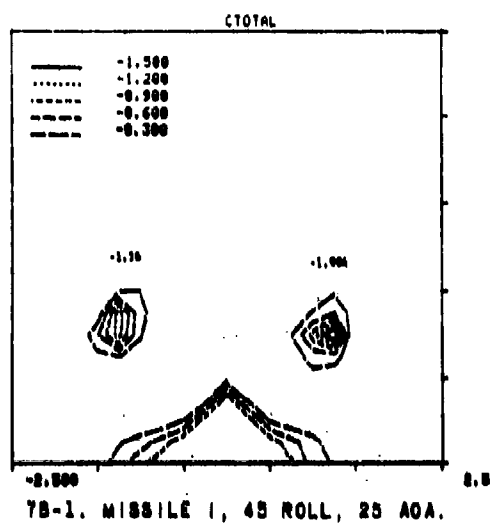


FIGURE C-7B. PRESSURE CONTOUR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.

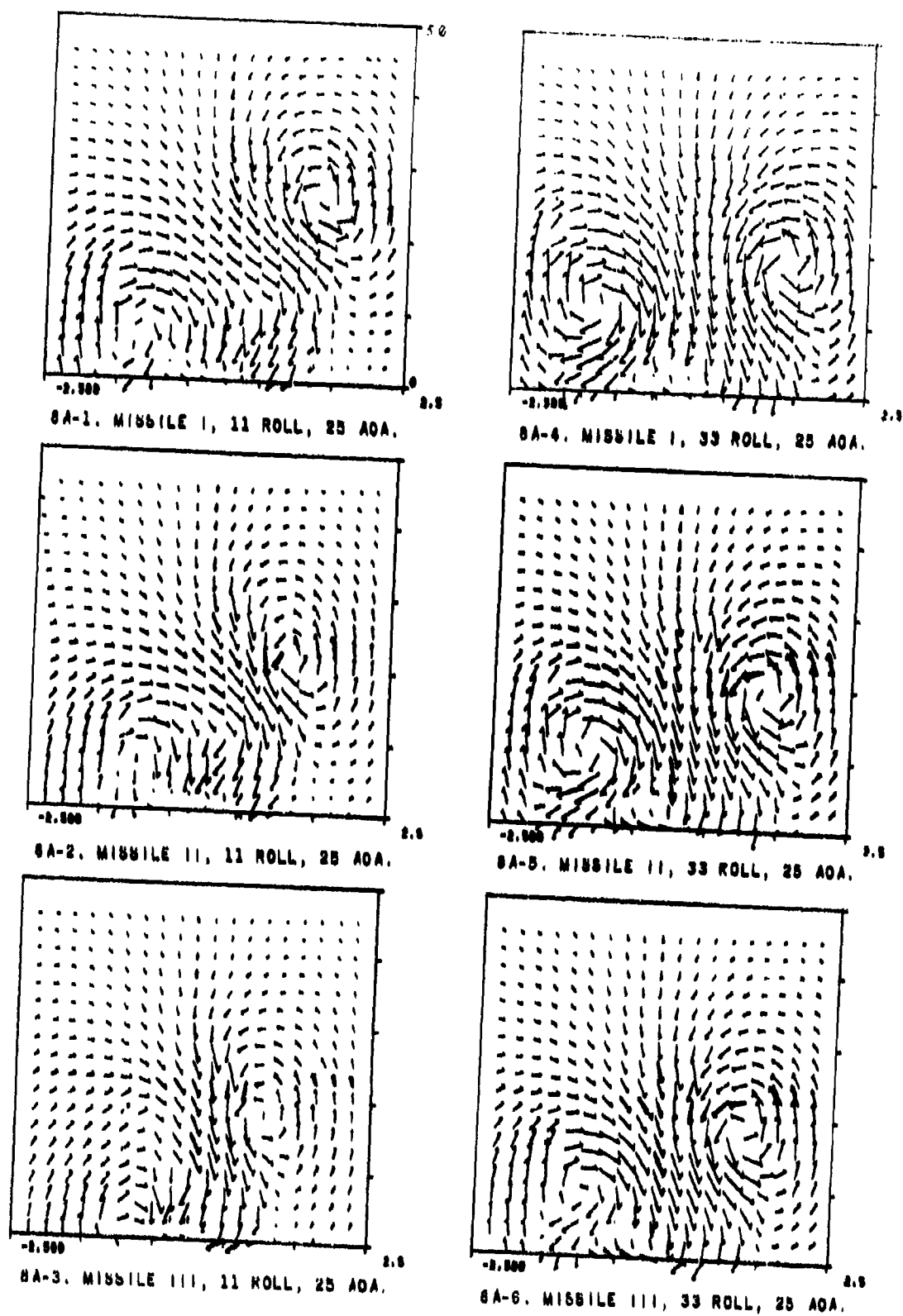


FIGURE C-8A. VELOCITY VECTOR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.

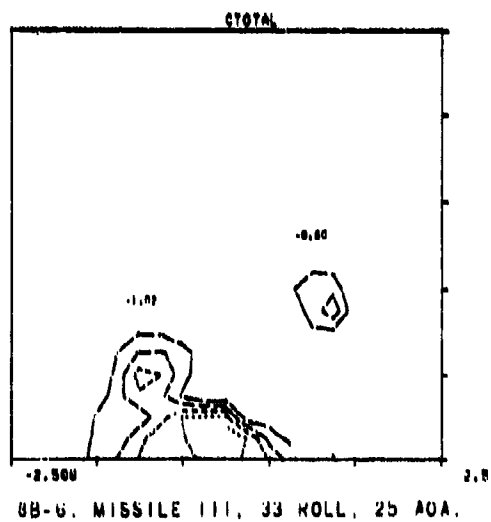
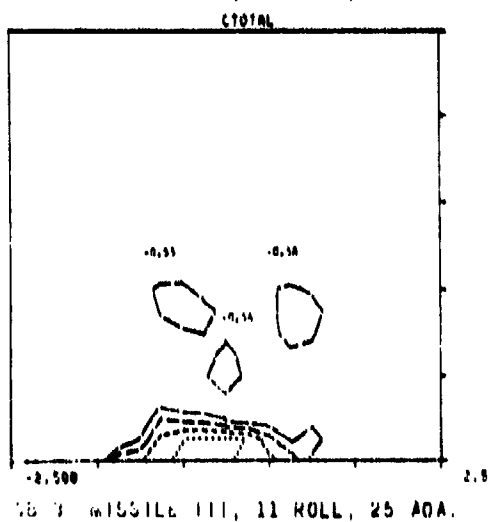
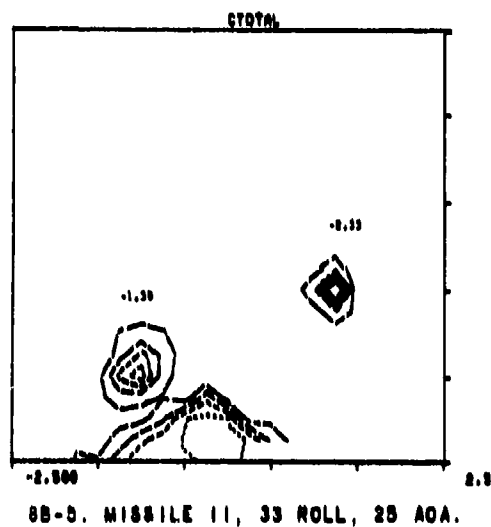
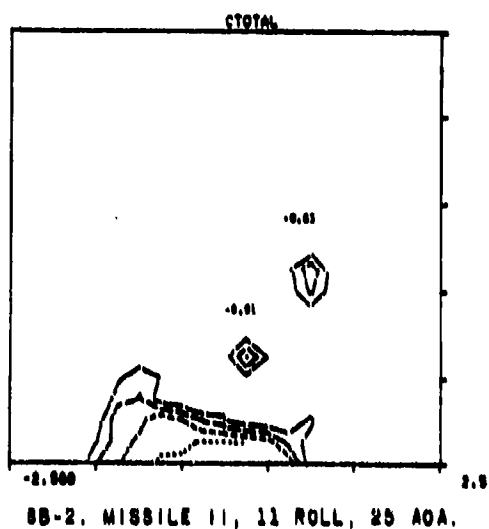
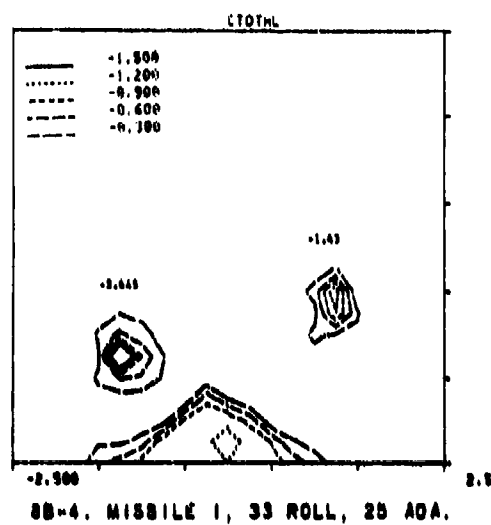
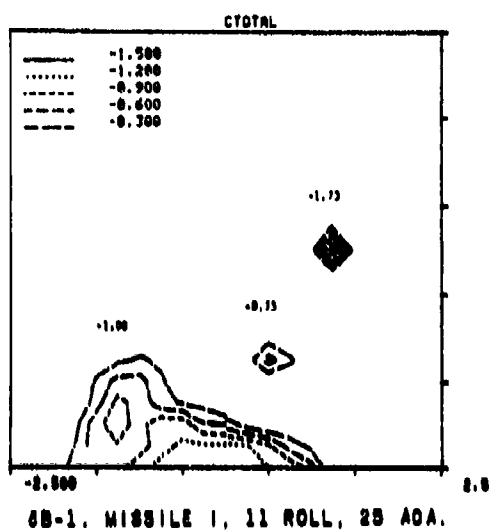


FIGURE C-8B. PRESSURE CONTOUR FLOWFIELD PROFILES.  
AFT PLANE, VIEW LOOKING UPSTREAM.

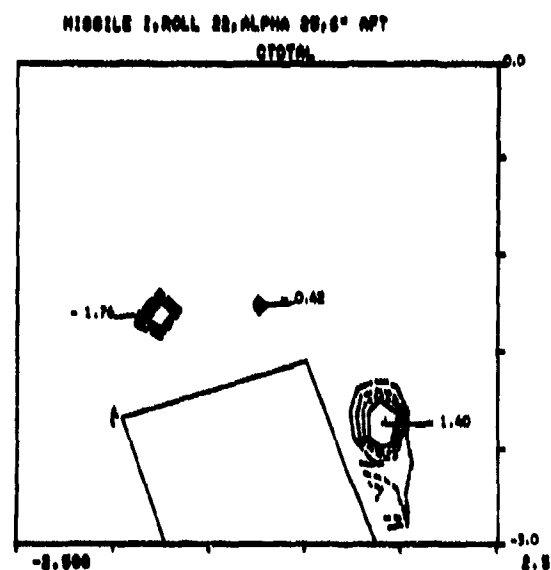
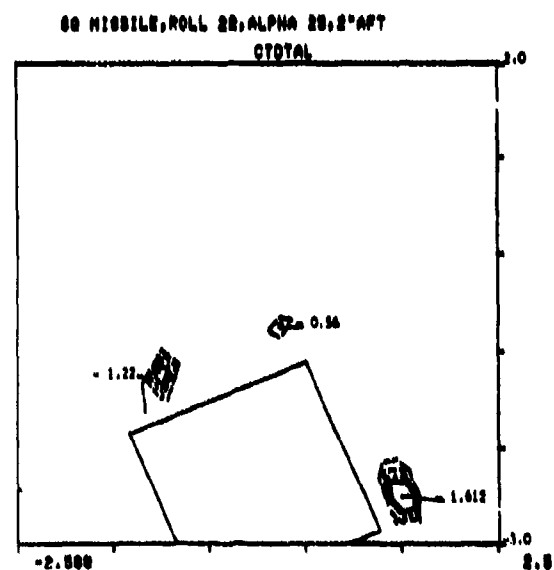
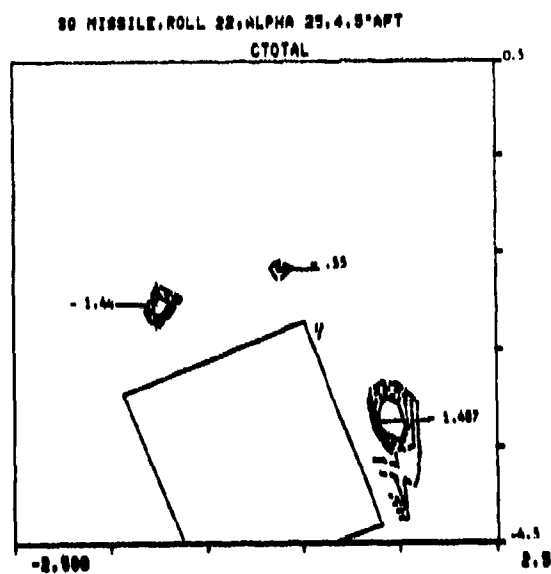
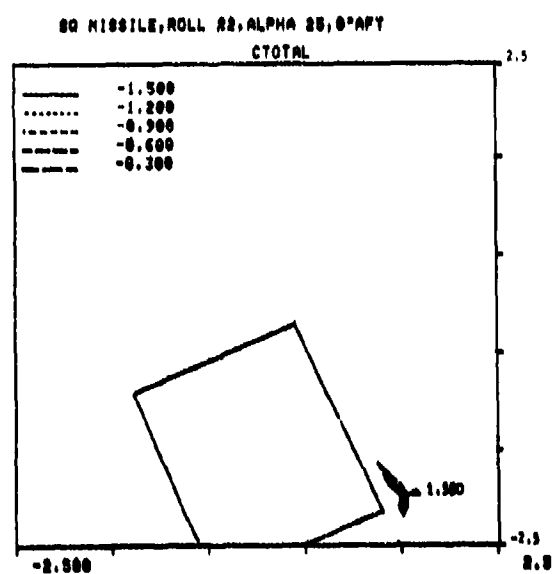


FIGURE C-9A. PRESSURE CONTOUR FLOWFIELD PROFILES, MISSILE I  
22 ROLL, 25 AOA. 0-2-4-6 INCHES AFT OF NOSE-BODY  
JUNCTION. VIEW LOOKING DOWNSTREAM. INCLUDING SIDES.



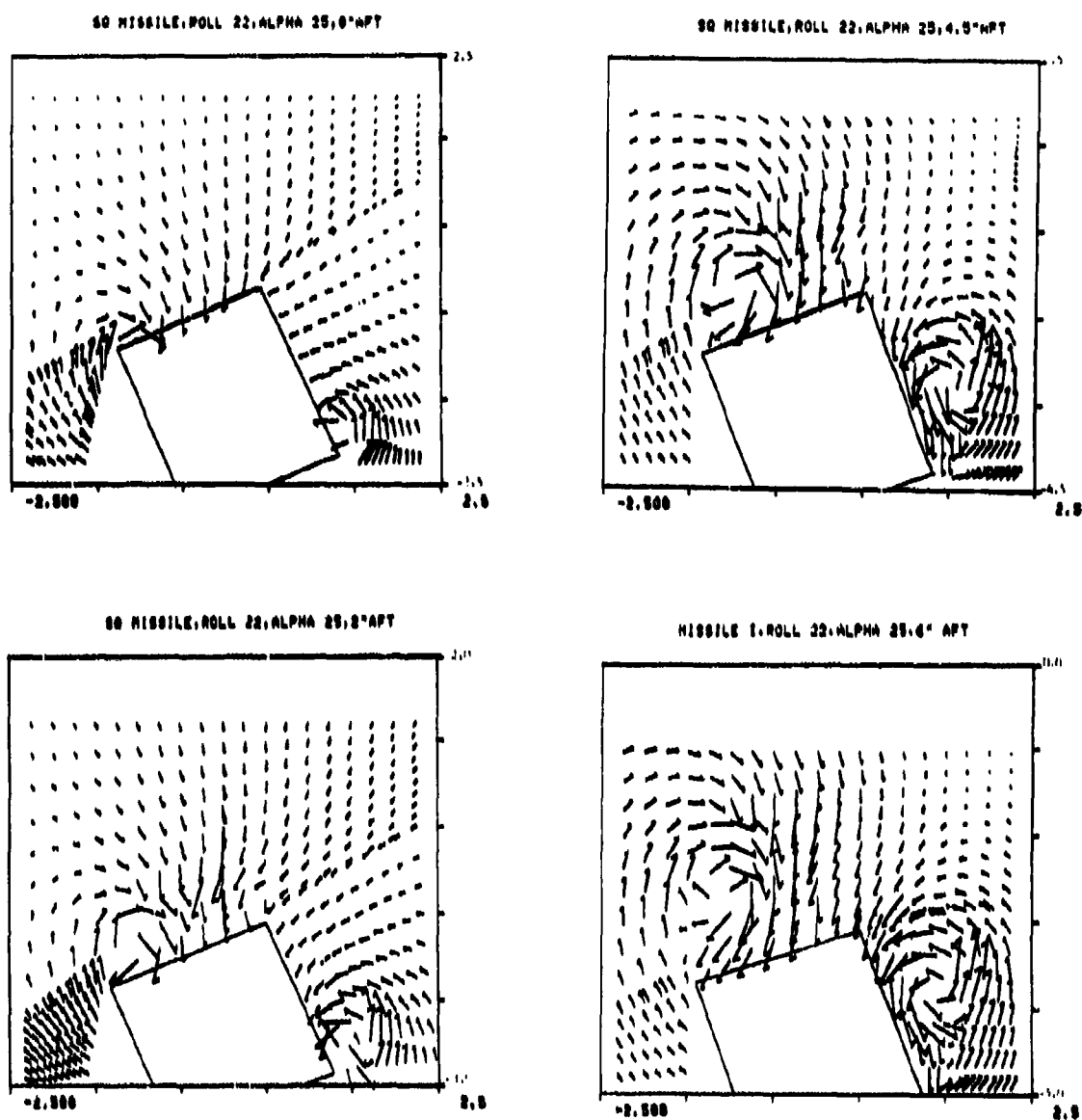


FIGURE C-9B. VELOCITY VECTOR FLOWFIELD PROFILES, MISSILE I  
22 ROLL, 25 AOA. 0-2-4-6 INCHES AFT OF NOSE-BODY  
JUNCTION. VIEW LOOKING DOWNSTREAM. INCLUDING SIDES.

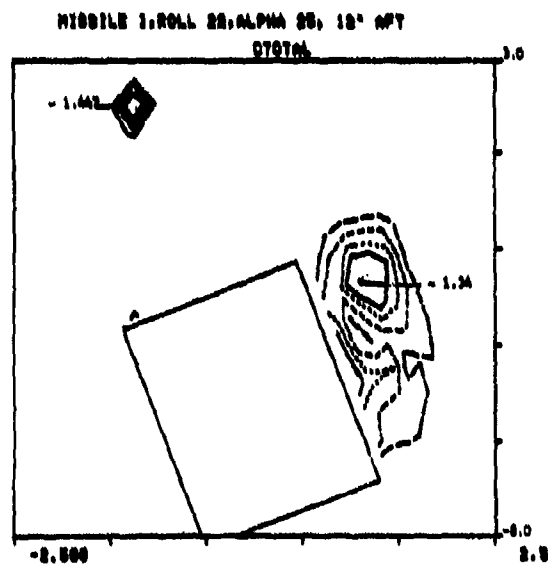
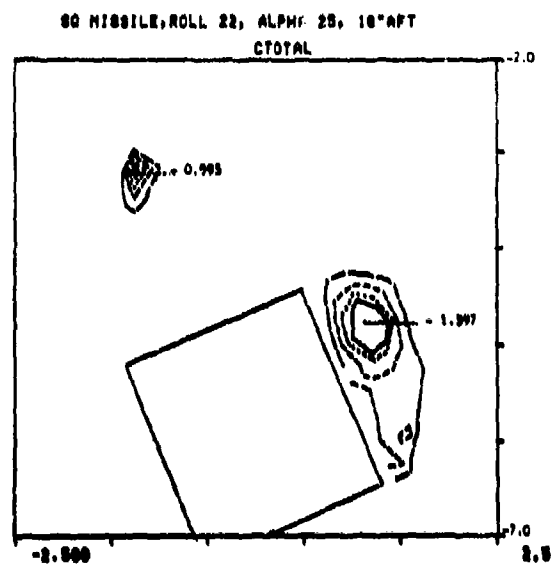
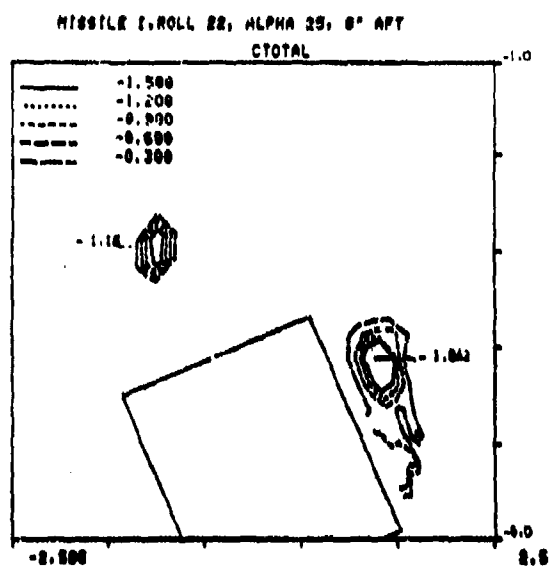


FIGURE C-10A. PRESSURE CONTOUR FLOWFIELD PROFILES, MISSILE I  
22 ROLL, 25 AOA. 8-10-12 INCHES AFT OF NOSE-BODY  
JUNCTION. VIEW LOOKING DOWNSTREAM. INCLUDING SIDES.

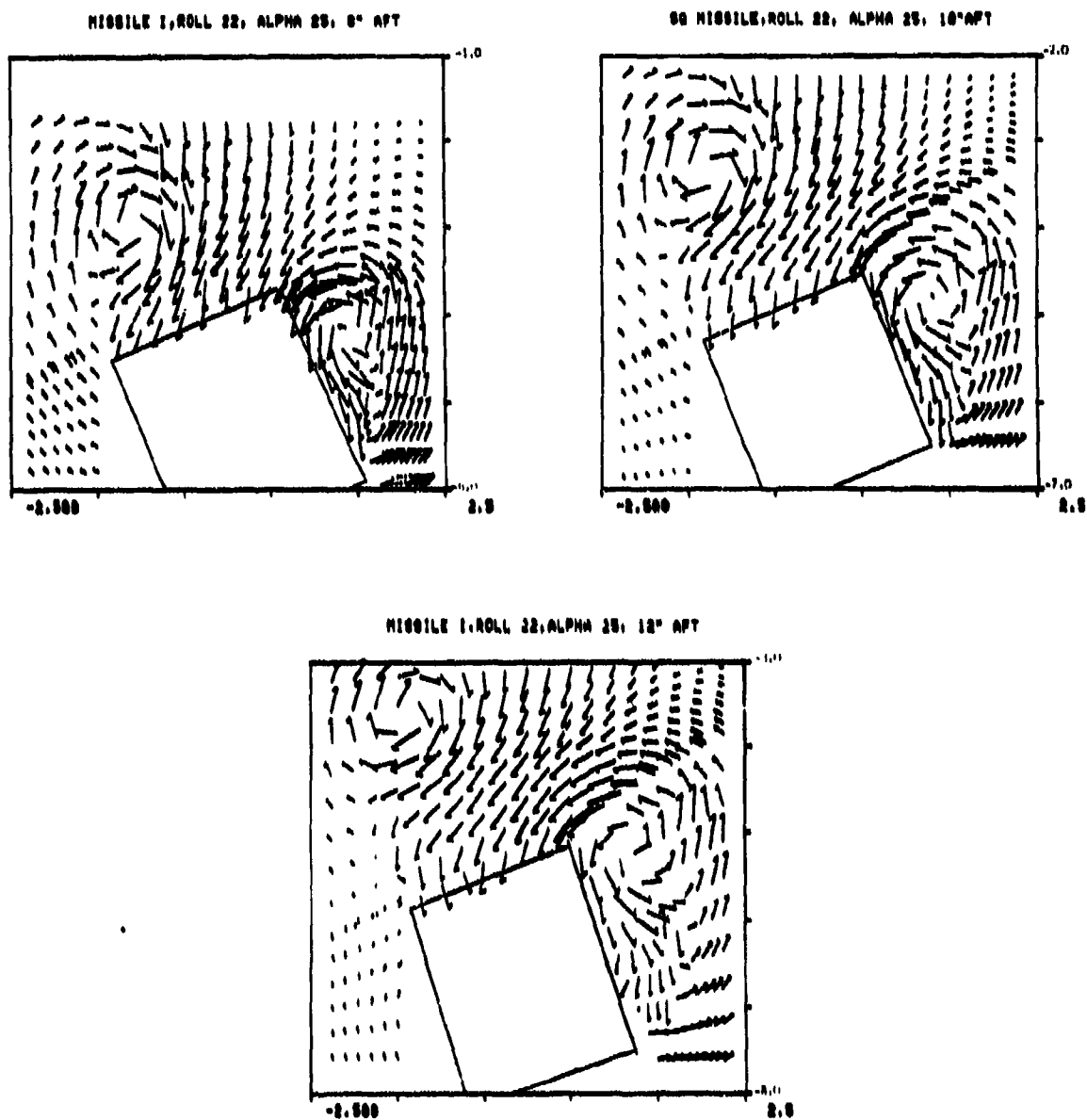


FIGURE C-10B. VELOCITY VECTOR FLOWFIELD PROFILES, MISSILE I  
22 ROLL, 25 AOA. 8-10-12 INCHES AFT OF NOSE-BODY  
JUNCTION. VIEW LOOKING DOWNSTREAM. INCLUDING SIDES.

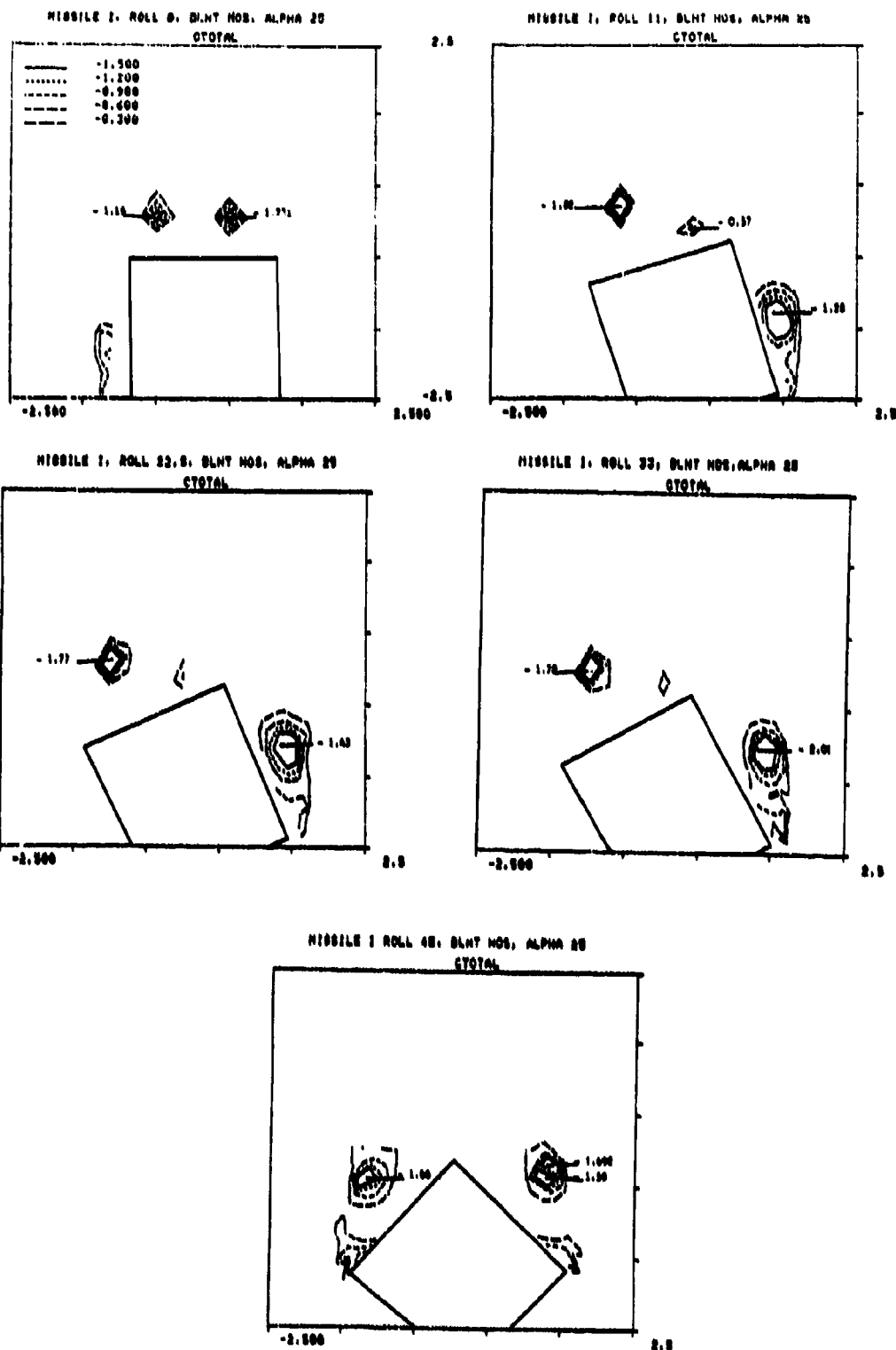
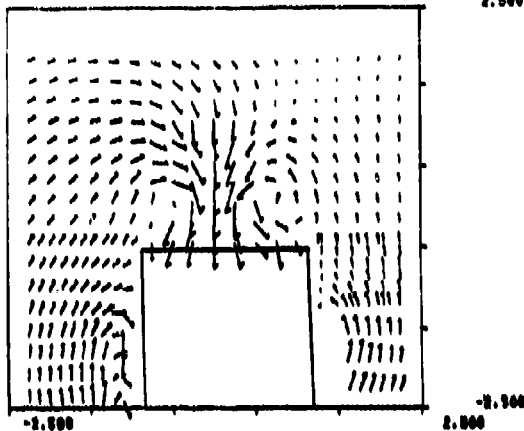
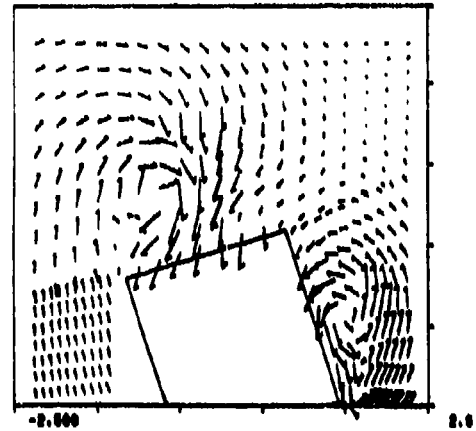


FIGURE C-11A. PRESSURE CONTOUR FLOWFIELD PROFILES, MISSILE I  
0-11-22-33-45 ROLL, 2/3 AFT PLANE, VIEW LOOKING  
DOWNSTREAM, INCLUDING SIDES. 25 ANGLE OF ATTACK.

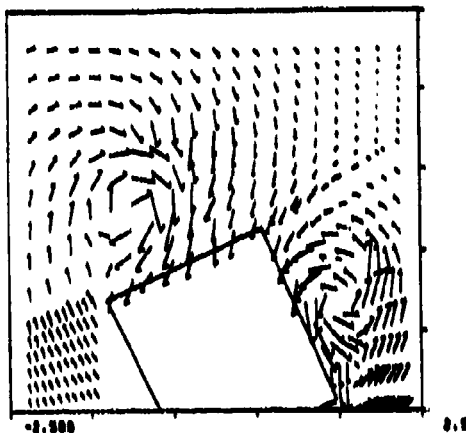
MISSILE 1, ROLL 0, BLNT HOB, ALPHA 25



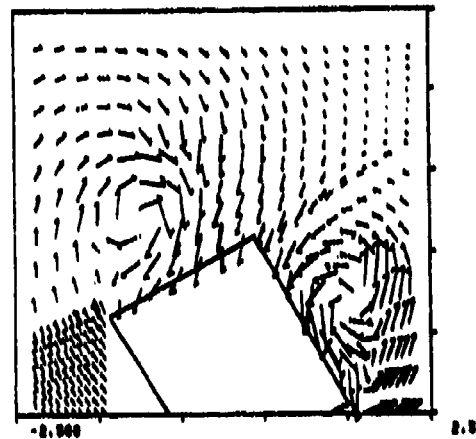
MISSILE 1, ROLL 11, BLNT HOB, ALPHA 25



MISSILE 1, ROLL 22.5, BLNT HOB, ALPHA 25



MISSILE 1, ROLL 33, BLNT HOB, ALPHA 25



MISSILE 1 ROLL 45, BLNT HOB, ALPHA 25

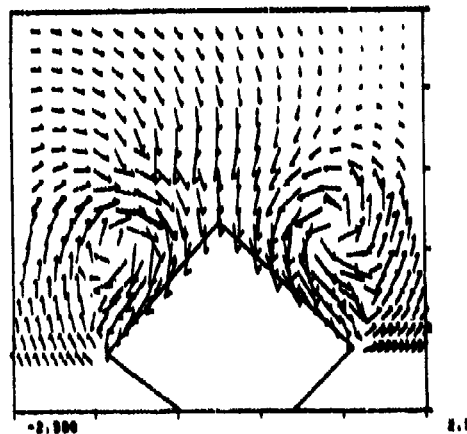


FIGURE C-11B. VELOCITY VECTOR FLOWFIELD PROFILES, MISSILE 1  
0-11-22-33-45 ROLL, 2/3 AFT PLANE, VIEW LOOKING  
DOWNSTREAM, INCLUDING SIDES. 25 ANGLE OF ATTACK.

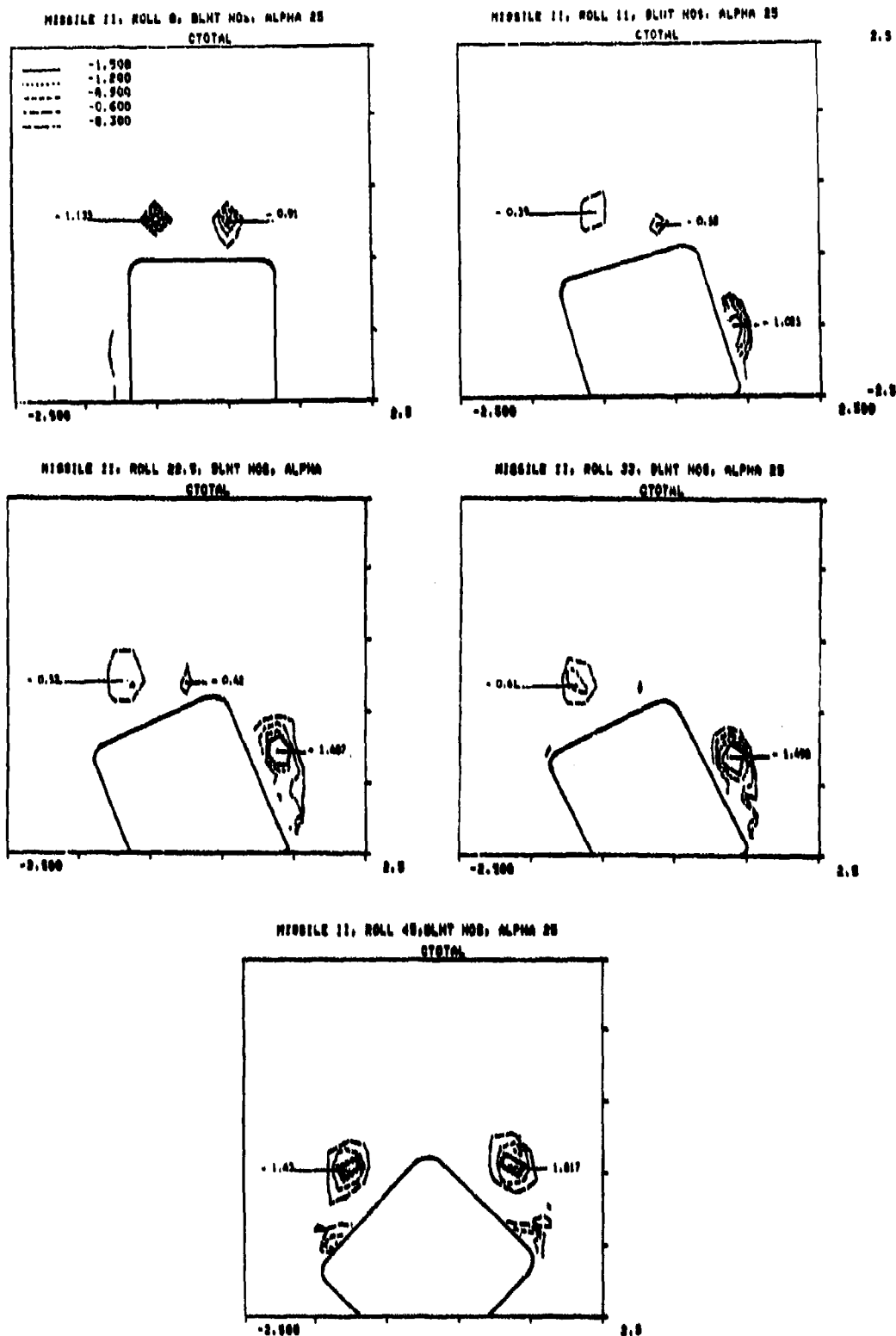
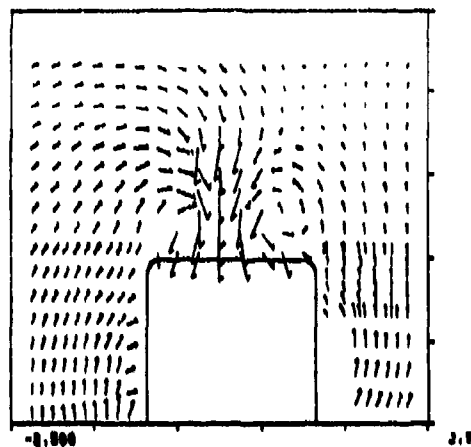
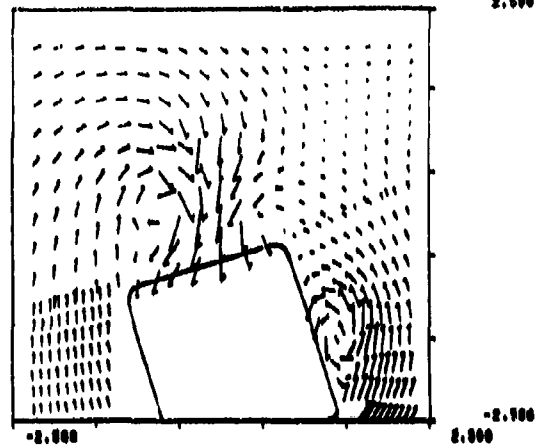


FIGURE C-12A. PRESSURE CONTOUR FLOWFIELD PROFILES, MISSILE II  
0-11-22-33-45 ROLL, 2/3 AFT PLANE, VIEW LOOKING  
DOWNSTREAM, INCLUDING SIDES. 25 ANGLE OF ATTACK.

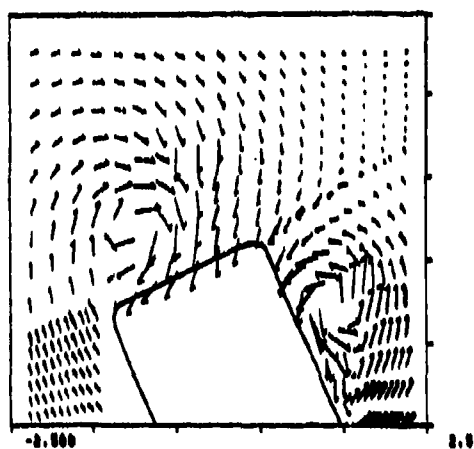
MISSILE II, ROLL 0, BLNT NOS, ALPHA 25



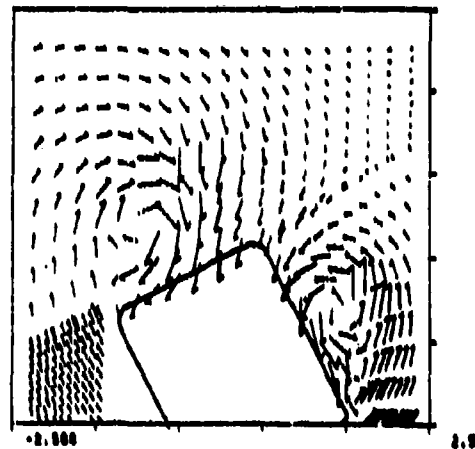
MISSILE II, ROLL 11, BLNT NOS, ALPHA 25 09:40 320-JUL-82



MISSILE II, ROLL 22.5, BLNT NOS, ALPHA



MISSILE II, ROLL 33, BLNT NOS, ALPHA 25



MISSILE II, ROLL 45, BLNT NOS, ALPHA 25

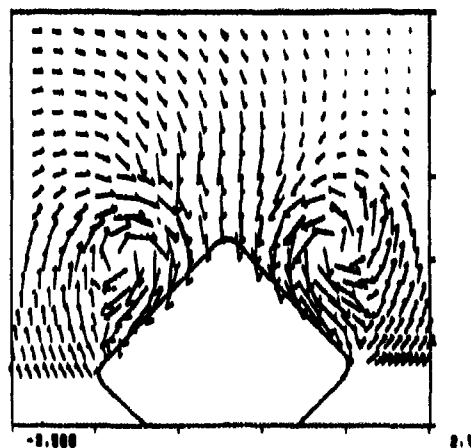


FIGURE C-12B. PRESSURE CONTOUR FLOWFIELD PROFILES, MISSILE II  
0-11-22-33-45 ROLL, 2/3 AFT PLANE, VIEW LOOKING  
DOWNSTREAM, INCLUDING SIDES. 25 ANGLE OF ATTACK.

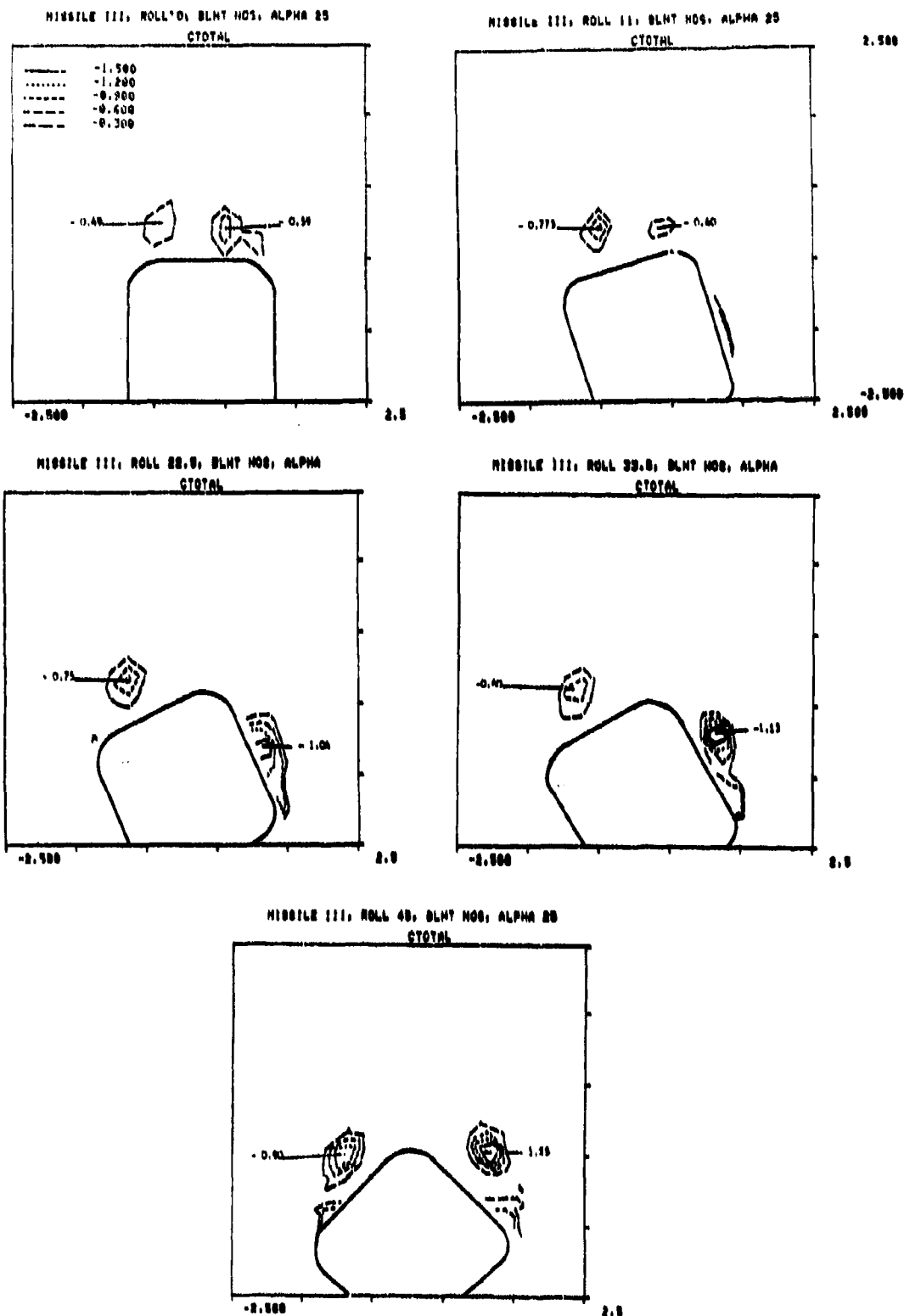
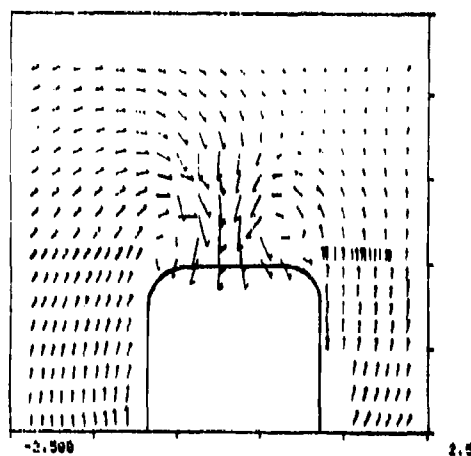


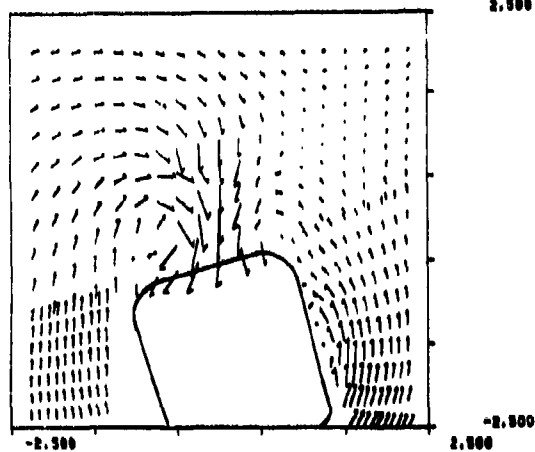
FIGURE C-13A. PRESSURE CONTOUR FLOWFIELD PROFILES, MISSILE III  
0-11-22-33-45 ROLL, 2/3 AFT PLANE, VIEW LOOKING  
DOWNSTREAM, INCLUDING SIDES. 25 ANGLE OF ATTACK.



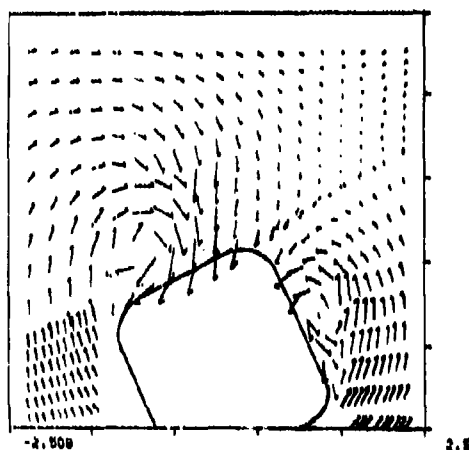
MISSILE III, ROLL 0, BLNT NOS, ALPHA 25



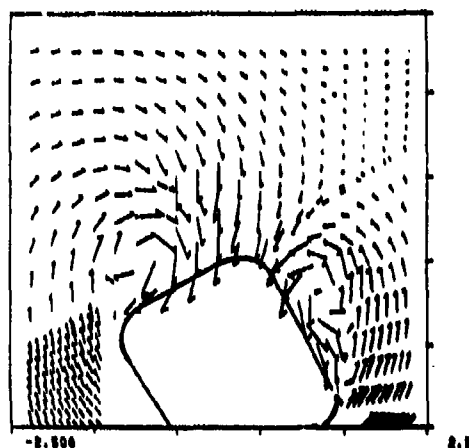
MISSILE III, ROLL 11, BLNT NOS, ALPHA 25



MISSILE III, ROLL 22.5, BLNT NOS, ALPHA



MISSILE III, ROLL 33.5, BLNT NOS, ALPHA



MISSILE III, ROLL 45, BLNT NOS, ALPHA 25

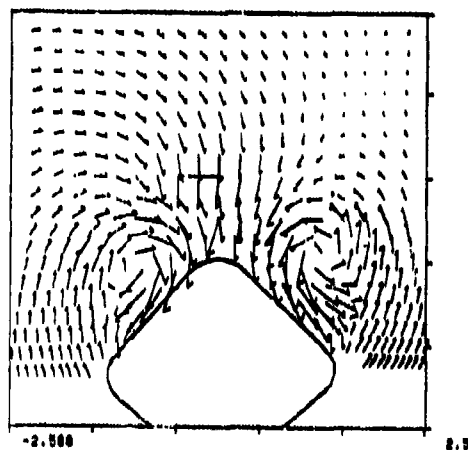


FIGURE C-13B. VELOCITY VECTOR FLOWFIELD PROFILES, MISSILE III  
0-11-22-33-45 ROLL, 2/3 AFT PLANE, VIEW LOOKING  
DOWNSTREAM, INCLUDING SIDES. 25 ANGLE OF ATTACK.

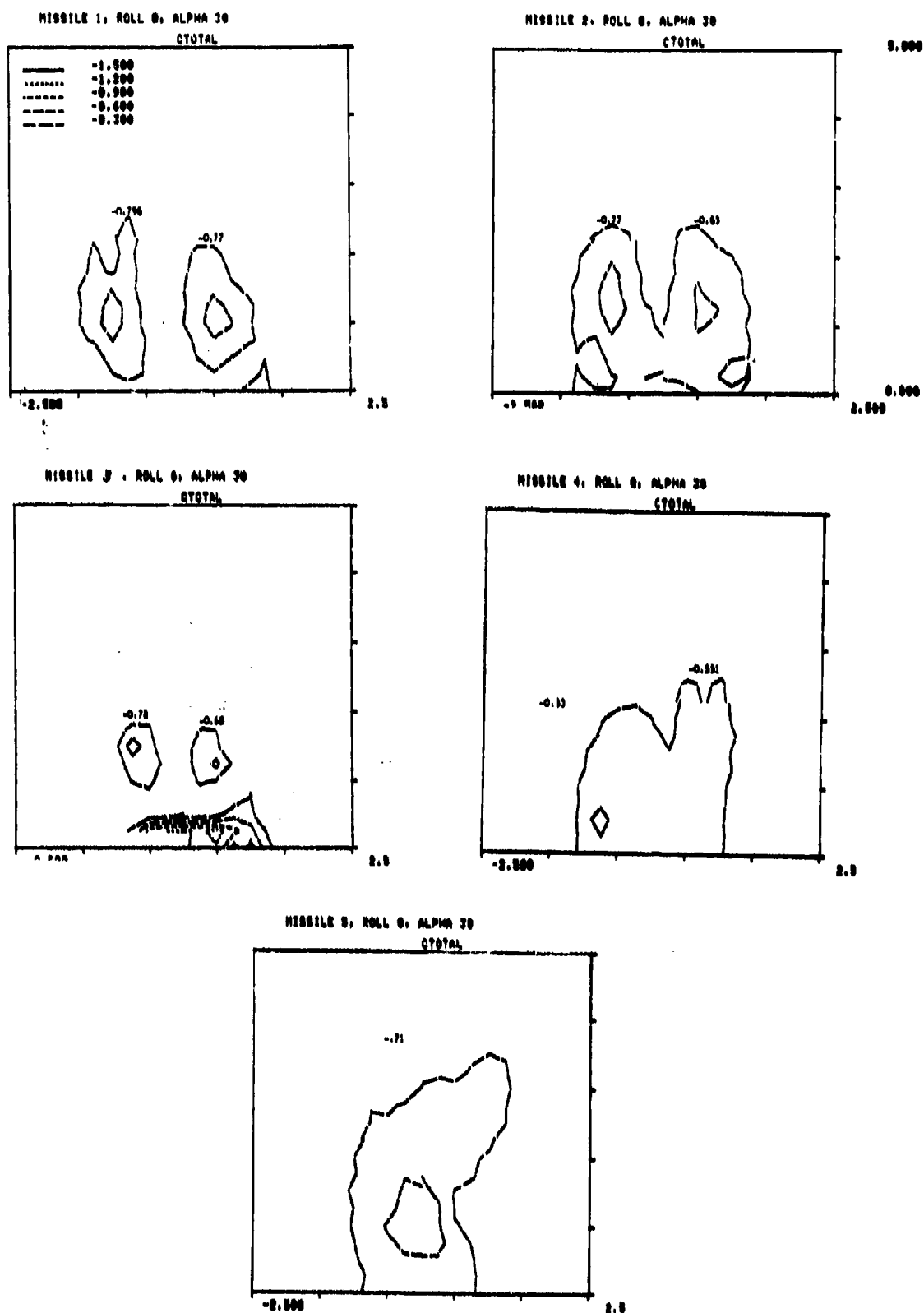
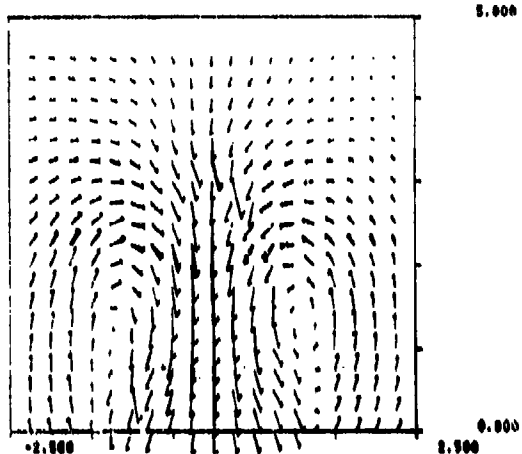
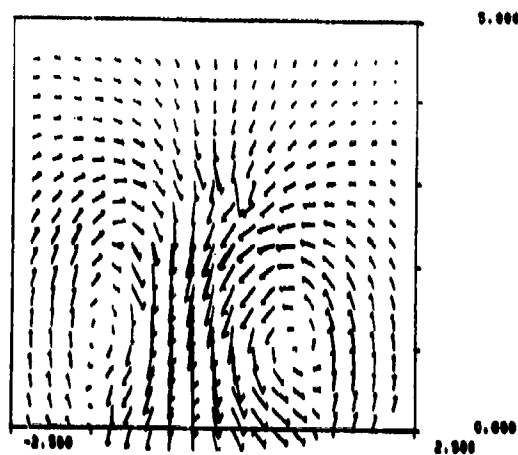


FIGURE C-14A. PRESSURE CONTOUR FLOWFIELD PROFILES, MISSILE 1-5  
 0 ROLL, 30 AOA, AFT PLANE, VIEW LOOKING UPSTREAM.

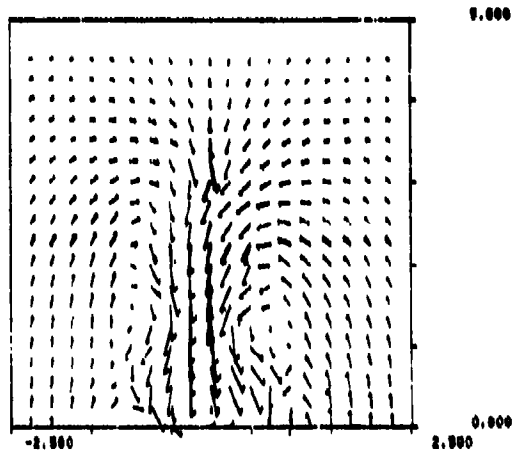
MISSILE 2, ROLL 0, ALPHA 30



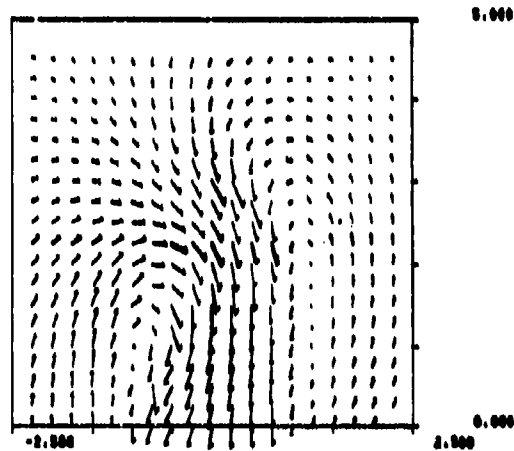
MISSILE 1, ROLL 0, ALPHA 30



MISSILE 3, ROLL 0, ALPHA 30



MISSILE 4, ROLL 0, ALPHA 30



MISSILE 5, ROLL 0, ALPHA 30

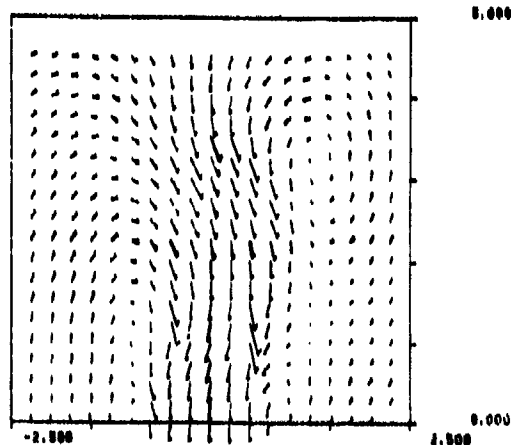


FIGURE C-14B. VELOCITY VECTOR FLOWFIELD PROFILES, MISSILES 1-5  
0 ROLL, 30 AOA, AFT PLANE, VIEW LOOKING UPSTREAM.

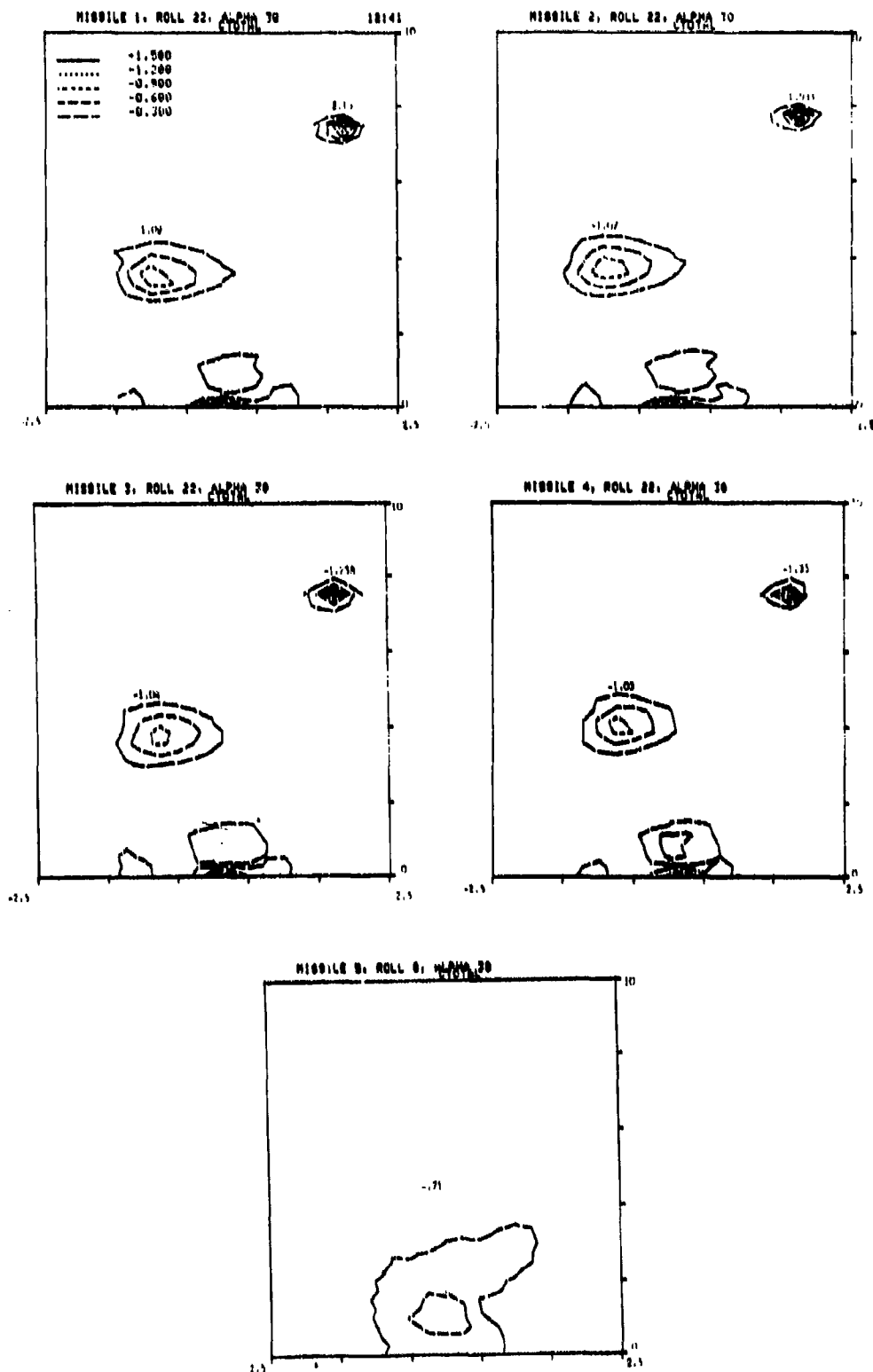


FIGURE C-15A. PRESSURE CONTOUR FLOWFIELD PROFILES, MISSILES 1-5  
22 ROLL, 30 AOA, AFT PLANE, VIEW LOOKING UPSTREAM.

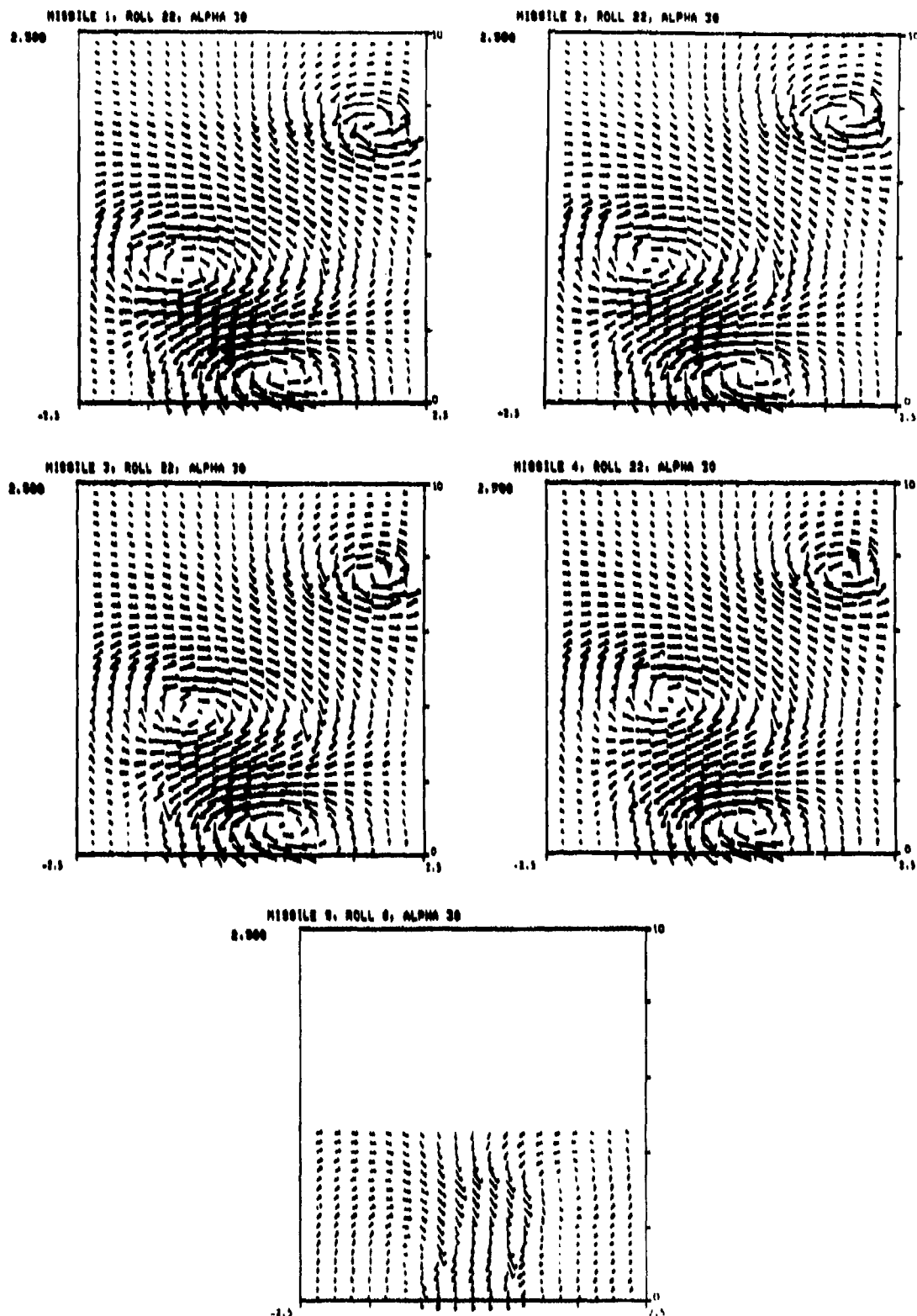


FIGURE C-15B. VELOCITY VECTOR FLOWFIELD PROFILES, MISSILES 1-5  
22 ROLL, 30 AOA, AFT PLANE, VIEW LOOKING UPSTREAM.

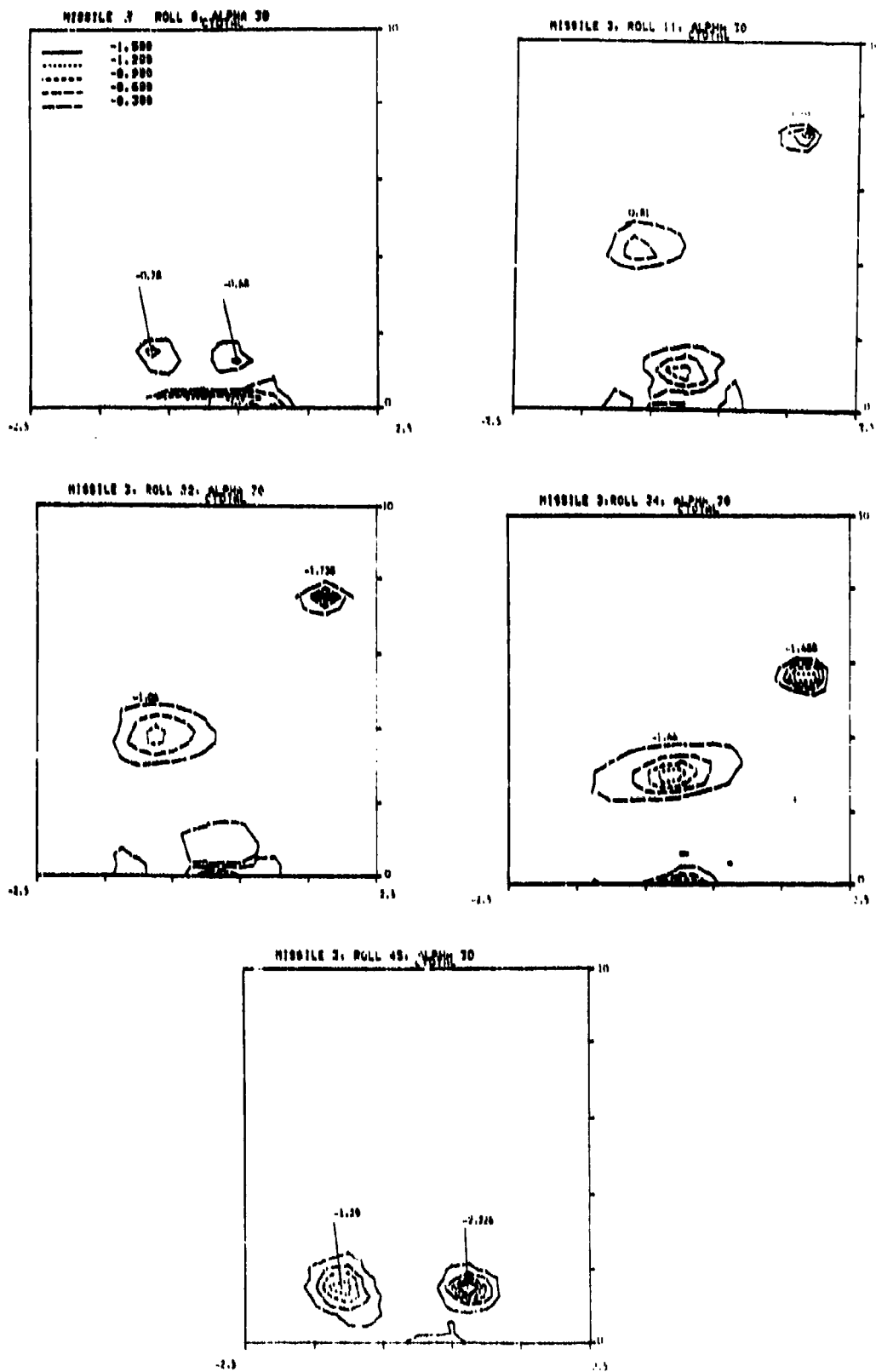


FIGURE C-16A. PRESSURE CONTOUR FLOWFIELD PROFILES, MISSILE 3  
0-11-22-33-45 ROLL, 30 AOA, AFT PLANE, VIEW LOOKING UPSTREAM.

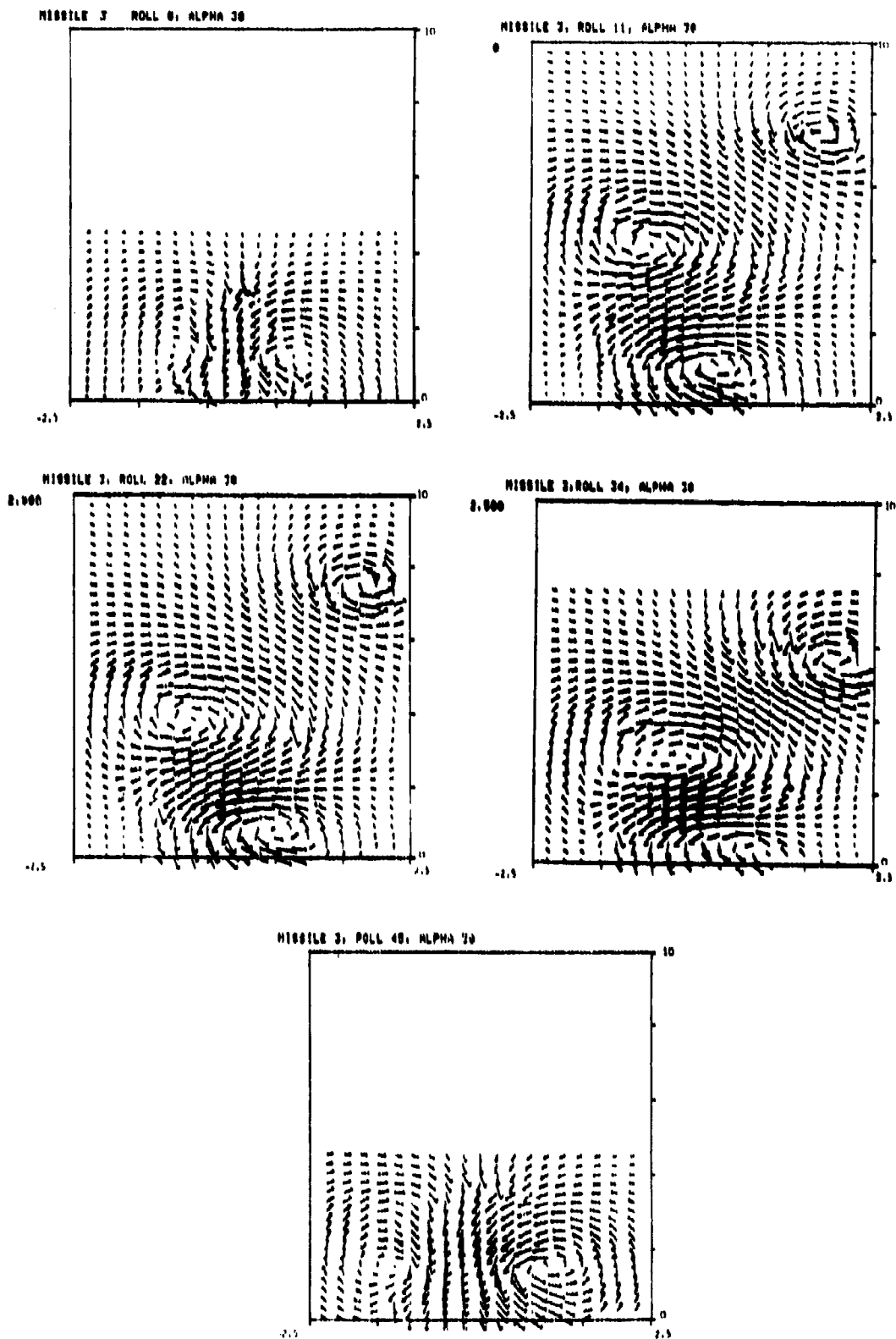


FIGURE C-16B. VELOCITY VECTOR FLOWFIELD PROFILES, MISSILE 3  
0-11-22-33-45 ROLL, 30 AOA, AFT PLANE, VIEW LOOKING UPSTREAM.

## APPENDIX D

### Tuft Grid Photographs of the Flowfield

Qualitative flowfield data were obtained for various missile configurations and orientations using a tuft grid. These tests were conducted by placing a grid of wool tufts in the flowfield on the leeward side of the missile, and then photographing the tuft patterns. The tests were conducted in the subsonic wind tunnel at a freestream velocity of 100 fps. All tests were conducted on missiles without fins.

Figure D.01 shows a schematic representation of the tuft grid test setup. The tuft grid was placed at 3 locations (forward, mid, and aft) along the leeward side of the missile body, perpendicular to the freestream velocity as shown in the figure. The forward plane was located at the nose-body junction of the missile, the mid plane 6 inches aft of the nose-body junction, and the aft plane at the aft end of the missile. A camera was mounted downstream of the model, and photographs were taken of the tufts in each of the 3 locations.

For missiles of fineness ratio 8, photographs were taken of tuft patterns in all 3 flowfield planes. The four different cross-section bodies with the blunt nose were tested at 10, 15, 20, and



25 degrees pitch and 0, 11, 22, 33, and 45 degrees roll. In addition, the 20% corner radius body with the pointed nose was tested at 10 and 25 degree pitch and 0, 22, and 45 degrees roll. Table D-1 shows the various missile configurations and orientations tested for missiles of fineness ratio 8. Figures D-1 through D-23 show the photographs of the tuft patterns for the various missile configurations and orientations tested. Since the camera was mounted downstream of the tufts, all photograph views are looking upstream or at the aft end of the missile.

For missiles of fineness ratio 16, photographs were taken of tuft patterns only in the aft plane. Five different cross-section bodies with the blunt nose were tested at 30 degree pitch and 0, 11, 22, 33, and 45 degrees roll. The square body was also tested at 10, 15, 20, and 25 degrees pitch and 22 and 45 degrees roll. These various missile configurations and orientations tested are shown in Table D-2, and the tuft photographs are shown in Figures D-23 through D-30. All tuft grid photographic views are looking upstream.

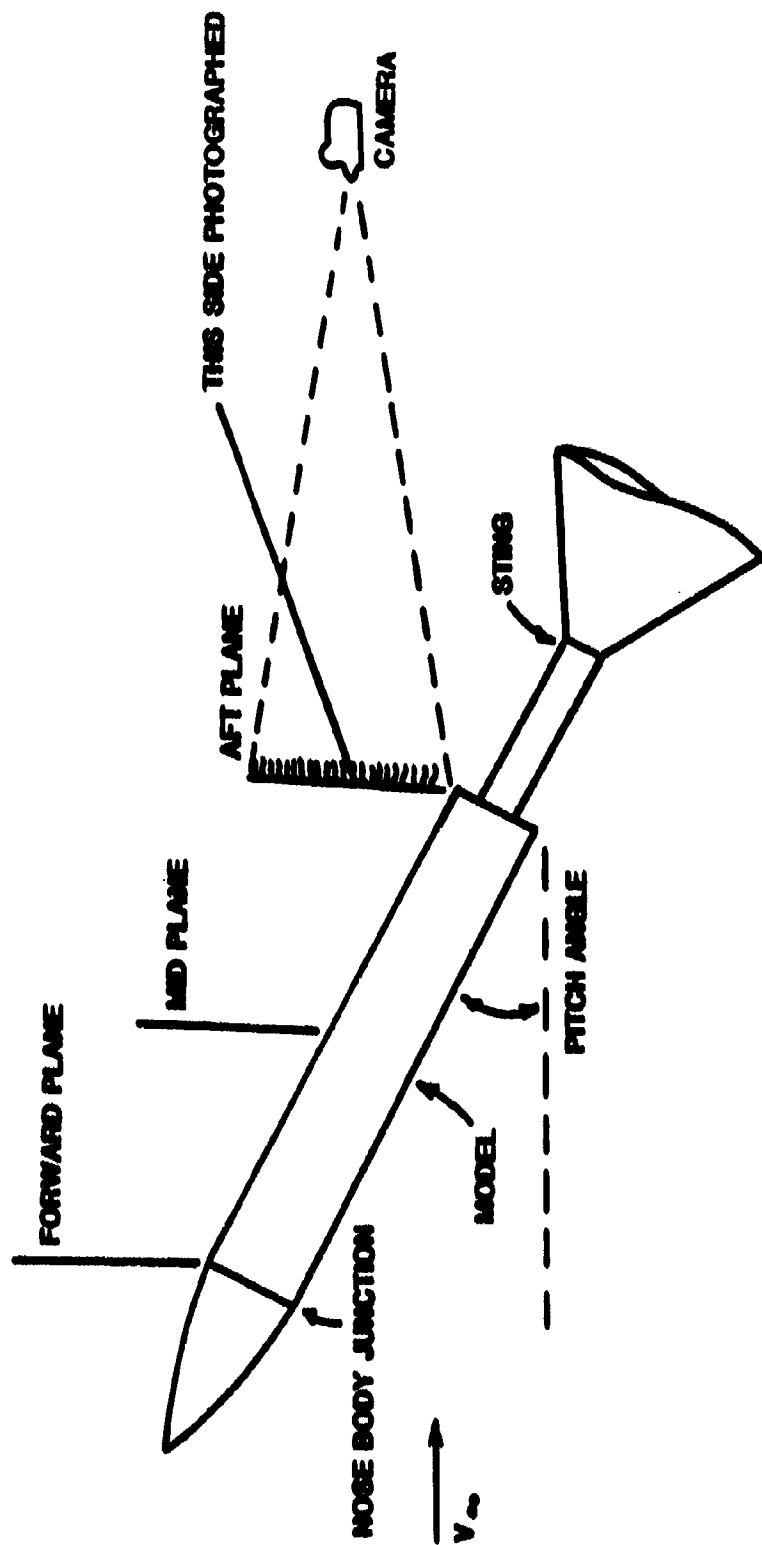


Figure D.01 Side View of Tuft Grid Test Setup

**TABLE D-1**  
**TUFT GRID PHOTOS FOR MISSILES OF FINENESS RATIO 8\***

| MISSILE<br>BODY | MOSE (1) | MOSE (2)<br>SHAPE | PITCH<br>ANGLE | ROLL<br>ANGLE          | GRID<br>LOCATION<br>(PLANE) | FIGURE |
|-----------------|----------|-------------------|----------------|------------------------|-----------------------------|--------|
| I               |          | BL                | 10°, 25°       | 0°, 22°, 45°           | Fwd                         | D-1    |
| I               |          | BL                | 10°, 25°       | 0°, 22°, 45°           | Mid                         | D-2    |
| I               |          | BL                | 20°            | 0°, 11°, 22°, 33°, 45° | Mid                         | D-3    |
| I               |          | BL                | 10°            | 0°, 22°, 45°           | Aft                         | D-4    |
| I               |          | BL                | 15°            | 0°, 11°, 22°, 33°, 45° | Aft                         | D-5    |
| I               |          | BL                | 20°            | 0°, 11°, 33°, 45°      | Aft                         | D-6    |
| I               |          | BL                | 25°            | 0°, 11°, 22°, 33°, 45° | Aft                         | D-7    |
| II              |          | BL                | 10°, 25°       | 0°, 22°, 45°           | Fwd                         | D-8    |
| II              |          | BL                | 10°, 25°       | 0°, 22°, 45°           | Mid                         | D-9    |
| II              |          | BL                | 10°            | 0°, 22°, 45°           | Aft                         | D-10   |
| II              |          | BL                | 15°            | 0°, 11°, 22°, 33°, 45° | Aft                         | D-11   |
| II              |          | BL                | 20°            | 0°, 11°, 22°, 33°, 45° | Aft                         | D-12   |
| II              |          | BL                | 25°            | 0°, 11°, 22°, 33°, 45° | Aft                         | D-13   |
| XII             |          | BL                | 10°, 25°       | 0°, 22°, 45°           | Fwd                         | D-14   |
| XII             |          | BL                | 10°, 25°       | 0°, 22°, 45°           | Mid                         | D-15   |

TABLE D-1

TUFT GRID PHOTOS FOR MISSILES OF FINENESS RATIO 8\*

| MISSILE<br>BODY | (1) | MOSE<br>(2)<br>SHAPE | PITCH<br>ANGLE | ROLL<br>ANGLE          | GRID<br>(3)<br>LOCATION<br>(PLANE) | FIGURE |
|-----------------|-----|----------------------|----------------|------------------------|------------------------------------|--------|
| III             |     | BL                   | 10°            | 0°, 22°, 45°           | Aft                                | D-16   |
| III             |     | BL                   | 15°            | 0°, 11°, 22°, 33°, 45° | Aft                                | D-17   |
| III             |     | BL                   | 20°            | 0°, 11°, 22°, 33°, 45° | Aft                                | D-18   |
| III             |     | BL                   | 25°            | 0°, 11°, 22°, 33°, 45° | Aft                                | D-19   |
| III             |     | PT                   | 10°, 25°       | 0°, 22°, 45°           | Fwd                                | D-20   |
| III             |     | PT                   | 10°, 25°       | 0°, 22°, 45°           | Mid                                | D-21   |
| III             |     | PT                   | 10°, 25°       | 0°, 22°, 45°           | Aft                                | D-22   |
| IV              |     | BL                   | 15°, 20°, 25°  | 0°                     | Aft                                | D-23   |

\*Missiles with the blunt nose actually have a fineness ratio of 7.5 since the blunt nose is only 3 inches long as compared to the 4 inch long pointed nose.

| (1) Body configurations: | (2) Nose configurations: | (3) Grid Locations:                                    |
|--------------------------|--------------------------|--|
| I - Square               | BL - Blunt nose          | See Figure D.01 for location of forward and aft planes |
| II - 10% corner radius   | PT - Pointed nose        |  |
| III - 20% corner radius  |                          |  |
| IV - Round               |                          |  |

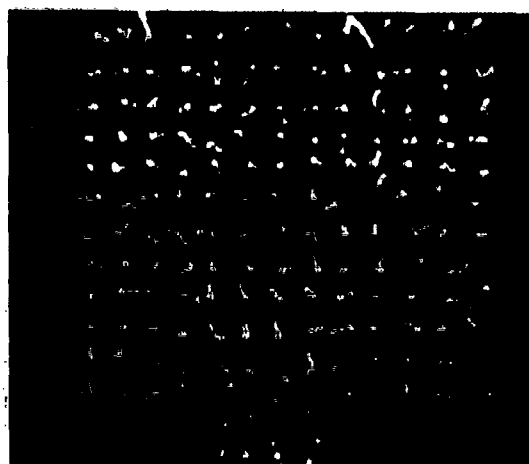
TABLE D-2

TUFT GRID PHOTOS FOR MISSILES OF FINENESS RATIO 16\*

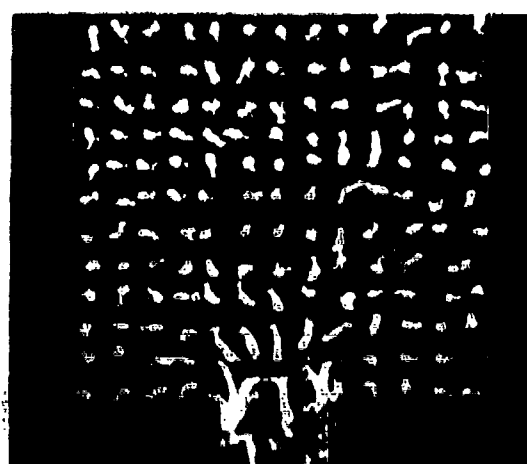
| MISSILE<br>BODY | NOSE<br>(2)<br>SHAPE | PITCH<br>ANGLE | ROLL<br>ANGLE          | GRID (3)<br>LOCATION<br>(PLANE) | FIGURE |
|-----------------|----------------------|----------------|------------------------|---------------------------------|--------|
| 1               | BL                   | 10°, 15°       | 22°, 45°               | Aft                             | D-24   |
| 1               | BL                   | 20°, 25°       | 22°, 45°               | Aft                             | D-25   |
| 1               | BL                   | 30°            | 0°, 11°, 22°, 33°, 45° | Aft                             | D-26   |
| 2               | BL                   | 30°            | 0°, 11°, 22°, 33°, 45° | Aft                             | D-27   |
| 3               | BL                   | 30°            | 0°, 11°, 22°, 33°, 45° | Aft                             | D-28   |
| 4               | BL                   | 30°            | 0°, 11°, 22°, 33°, 45° | Aft                             | D-29   |
| 5               | BL                   | 30°            | 0°                     | Aft                             | D-30   |

\*Missiles with the blunt nose actually have a fineness ratio of 15.33 since the blunt nose is only 3 inches long as compared to the 4 inch long pointed nose.

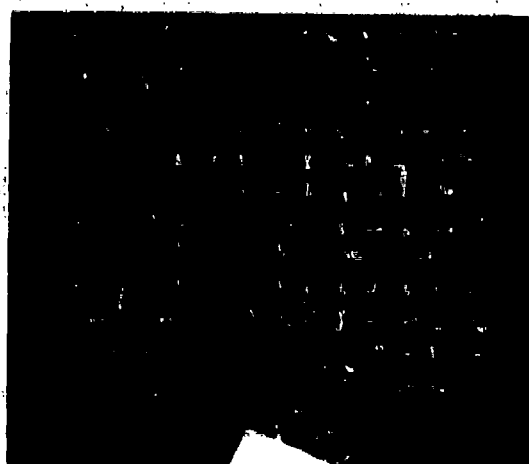
| (1) Body Configurations: | (2) Nose Configurations | (3) Grid Location:                        |
|--------------------------|-------------------------|---|
| 1 - Square               | BL - Blunt nose         | See Figure D.01 for location of aft plane |
| 2 - 10% corner radius    | PT - Pointed nose       |   |
| 3 - 20% corner radius    |                         |   |
| 4 - 30% corner radius    |                         |   |
| 5 - Round                |                         |   |



1a. MISSILE 1,  $0^\circ$  ROLL,  $10^\circ$  PITCH



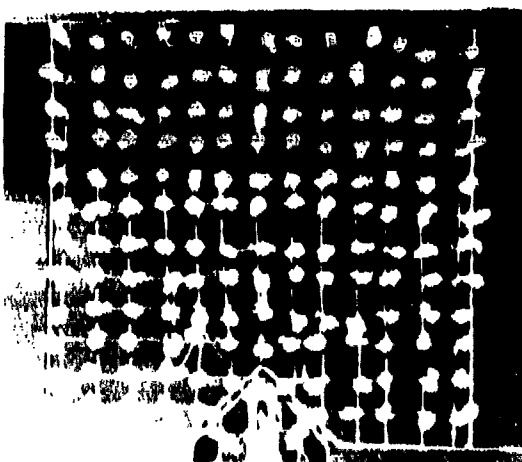
1d. MISSILE 1,  $0^\circ$  ROLL,  $25^\circ$  PITCH



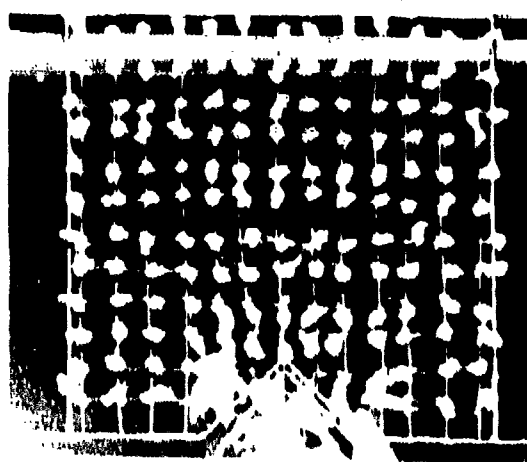
1b. MISSILE 1,  $22^\circ$  ROLL,  $10^\circ$  PITCH



1e. MISSILE 1,  $22^\circ$  ROLL,  $25^\circ$  PITCH

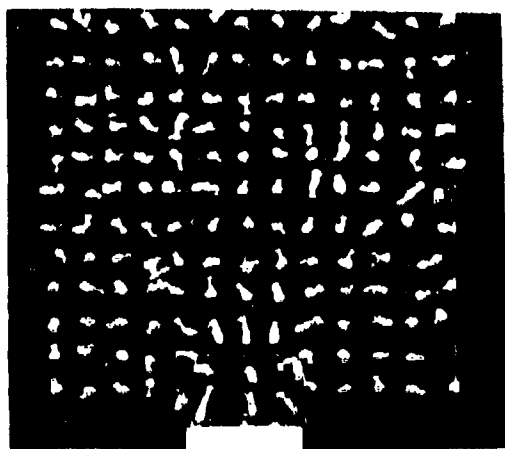


1c. MISSILE 1,  $45^\circ$  ROLL,  $10^\circ$  PITCH

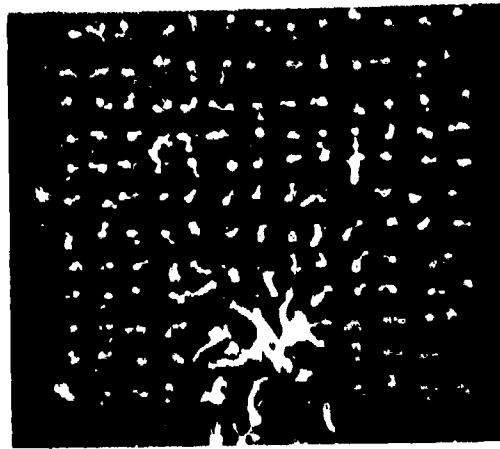


1f. MISSILE 1,  $45^\circ$  ROLL,  $25^\circ$  PITCH

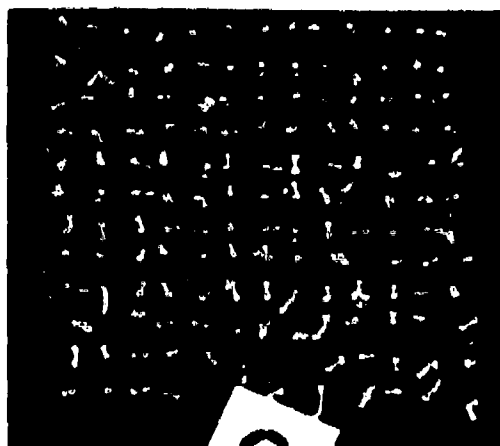
FIGURE D-1. TUFT GRID PHOTOS IN FORWARD PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



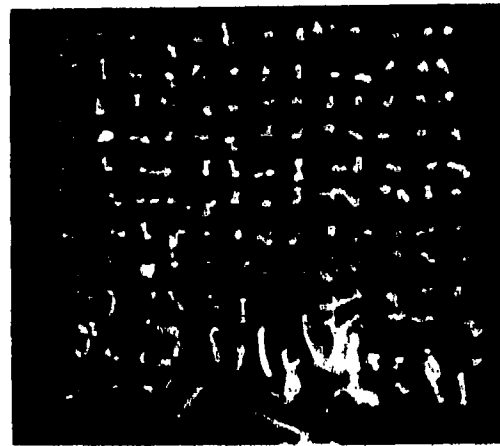
2a. MISSILE 1,  $0^\circ$  ROLL,  $10^\circ$  PITCH



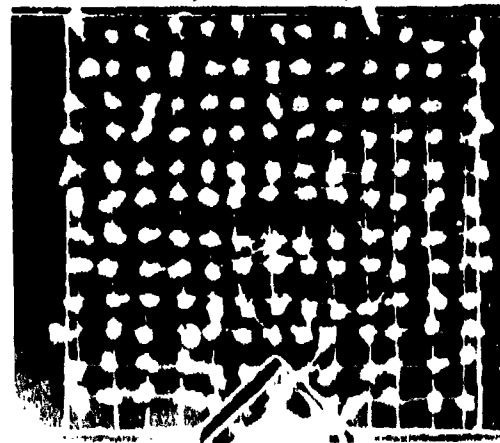
2d. MISSILE 1,  $0^\circ$  ROLL,  $25^\circ$  PITCH



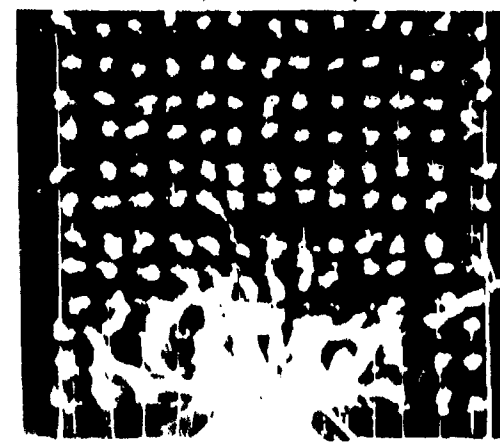
2b. MISSILE 1,  $22^\circ$  ROLL,  $10^\circ$  PITCH



2e. MISSILE 1,  $22^\circ$  ROLL,  $25^\circ$  PITCH

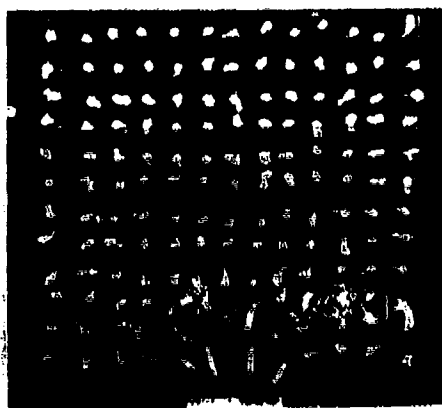


2c. MISSILE 1,  $45^\circ$  ROLL,  $10^\circ$  PITCH

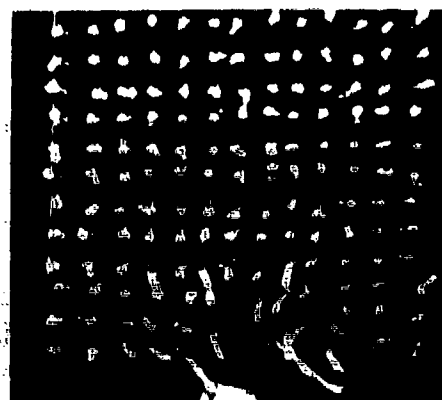


2f. MISSILE 1,  $45^\circ$  ROLL,  $25^\circ$  PITCH

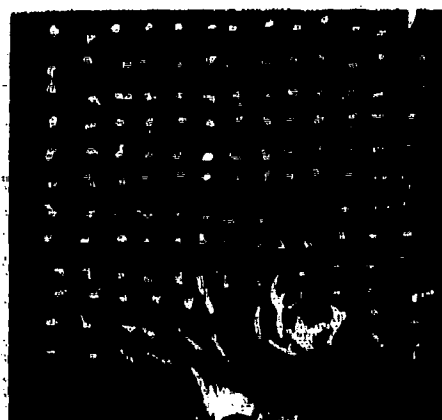
FIGURE D-2. TUFT GRID PHOTOS IN MID PLANE  
FOR MISSILE OF FINENESS RATIO 7.5



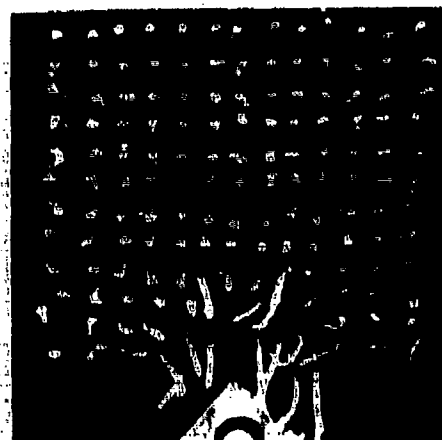
3a. MISSILE 1,  $0^\circ$  ROLL,  $20^\circ$  PITCH



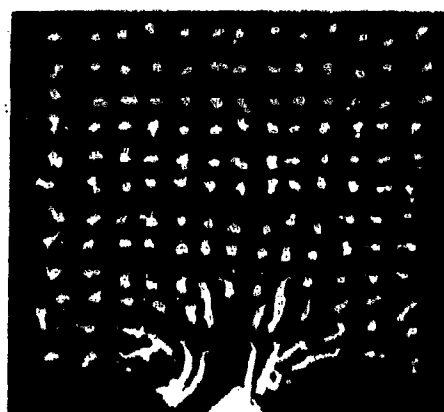
3b. MISSILE 1,  $11^\circ$  ROLL,  $20^\circ$  PITCH



3c. MISSILE 1,  $22^\circ$  ROLL,  $20^\circ$  PITCH



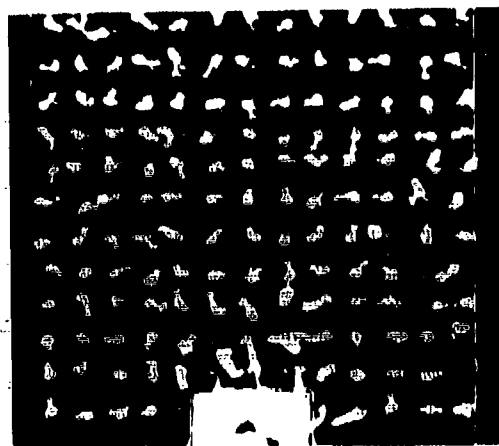
3d. MISSILE 1,  $33^\circ$  ROLL,  $20^\circ$  PITCH



3e. MISSILE 1,  $45^\circ$  ROLL,  $20^\circ$  PITCH

FIGURE D-3. TUFT GRID PHOTOS IN MID PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .

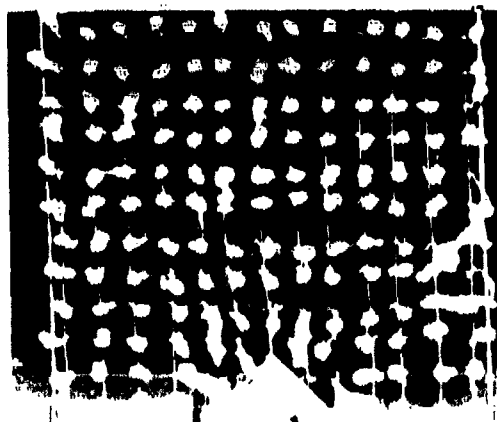




4a. MISSILE 1,  $0^\circ$  ROLL,  $10^\circ$  PITCH

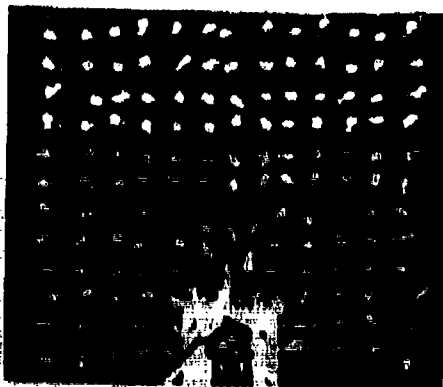


4b. MISSILE 1,  $22^\circ$  ROLL,  $10^\circ$  PITCH

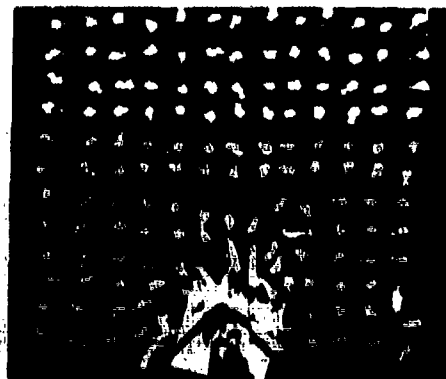


4c. MISSILE 1,  $45^\circ$  ROLL,  $10^\circ$  PITCH

FIGURE D-4. TUFT GRID PICTURES IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



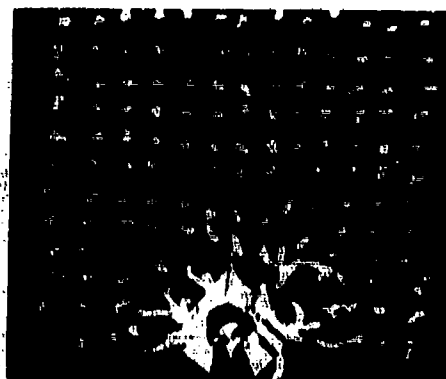
5a. MISSILE 1,  $0^\circ$  ROLL,  $15^\circ$  PITCH



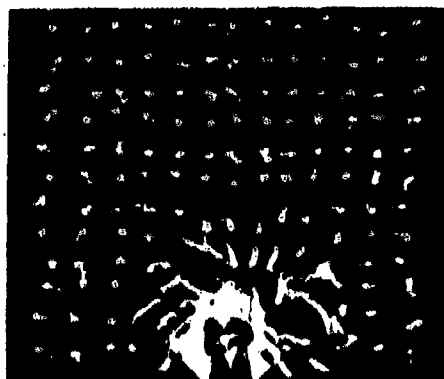
5b. MISSILE 1,  $11^\circ$  ROLL,  $15^\circ$  PITCH



5c. MISSILE 1,  $22^\circ$  ROLL,  $15^\circ$  PITCH

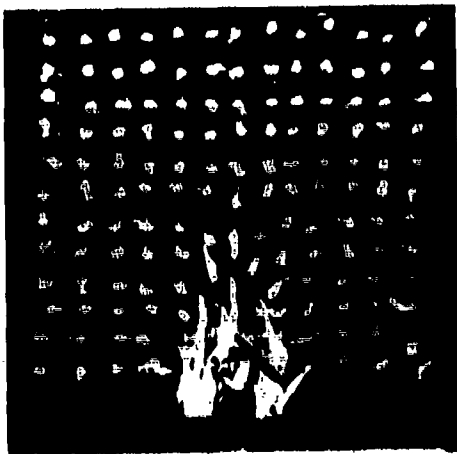


5d. MISSILE 1,  $33^\circ$  ROLL,  $15^\circ$  PITCH

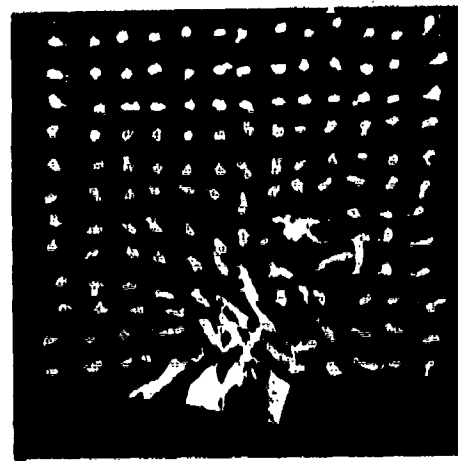


5e. MISSILE 1,  $45^\circ$  ROLL,  $15^\circ$  PITCH

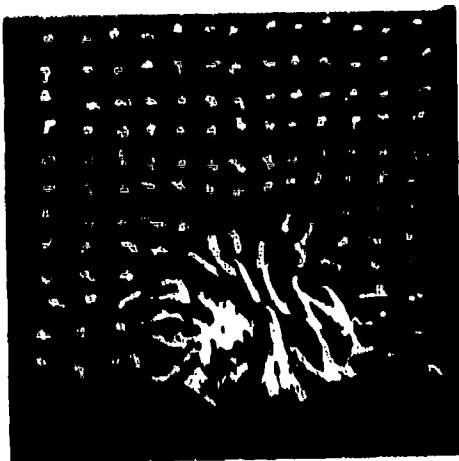
FIGURE D-5. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



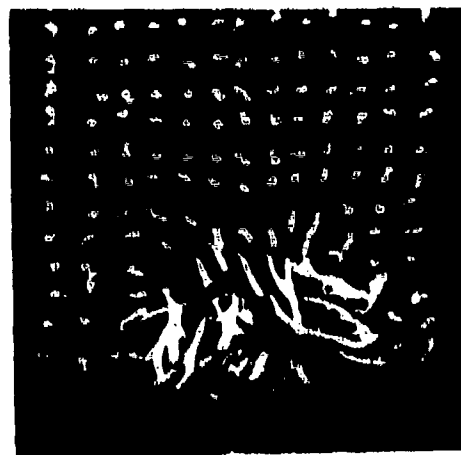
6a. MISSILE 1,  $0^\circ$  ROLL,  $20^\circ$  PITCH



6b. MISSILE 1,  $11^\circ$  ROLL,  $20^\circ$  PITCH

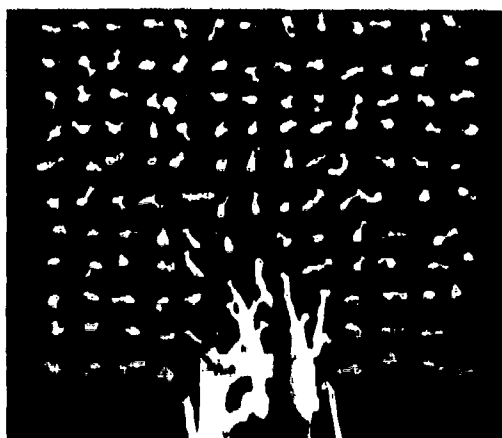


6c. MISSILE 1,  $33^\circ$  ROLL,  $20^\circ$  PITCH

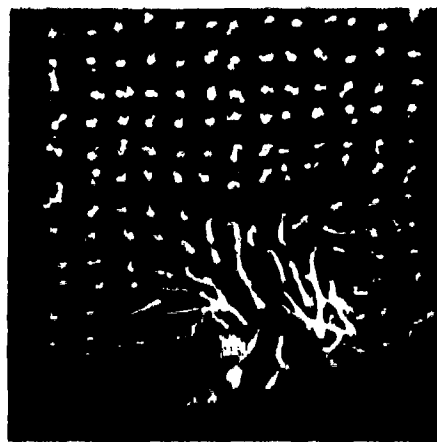


6d. MISSILE 1,  $45^\circ$  ROLL,  $20^\circ$  PITCH

FIGURE D-G. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



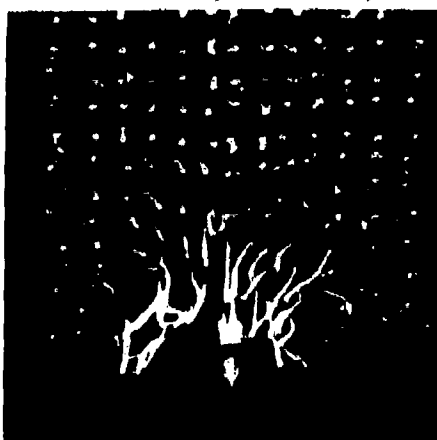
7a. MISSILE 1,  $0^\circ$  ROLL,  $25^\circ$  PITCH



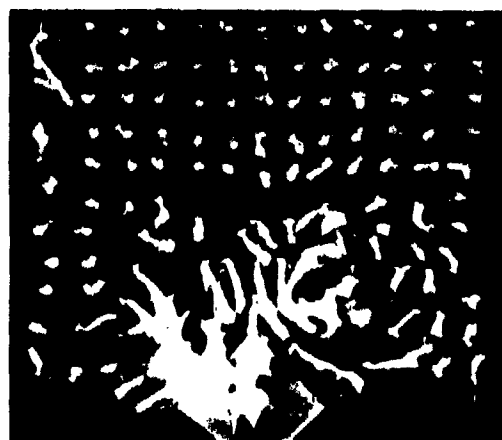
7b. MISSILE 1,  $11^\circ$  ROLL,  $25^\circ$  PITCH



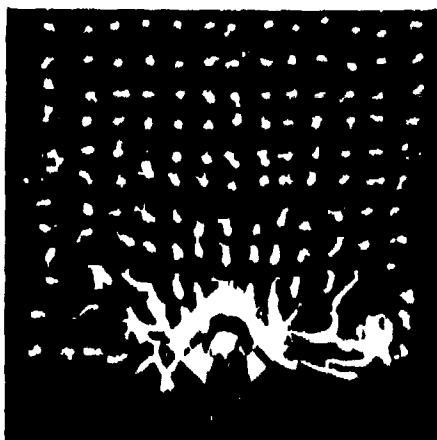
7c. MISSILE 1,  $22^\circ$  ROLL,  $25^\circ$  PITCH



7d. MISSILE 1,  $33^\circ$  ROLL,  $25^\circ$  PITCH

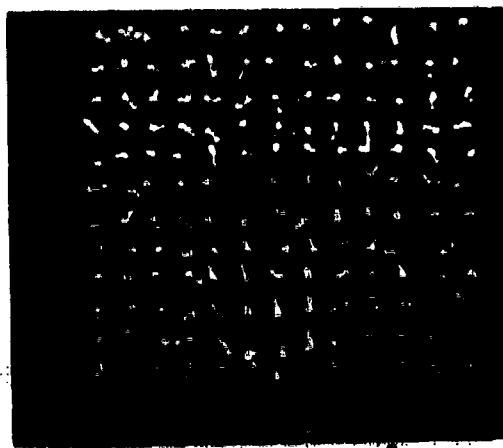


7e. MISSILE 1,  $45^\circ$  ROLL,  $25^\circ$  PITCH

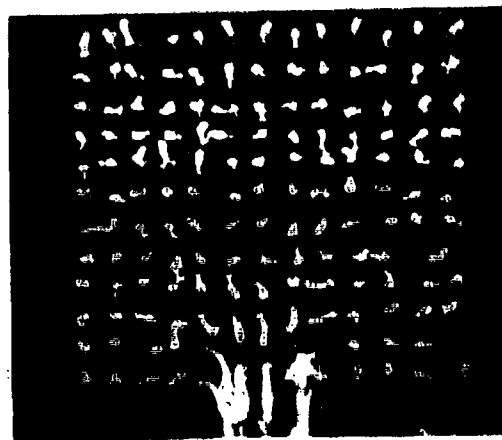


7f. MISSILE 1,  $45^\circ$  ROLL,  $25^\circ$  PITCH, FIN CONF.

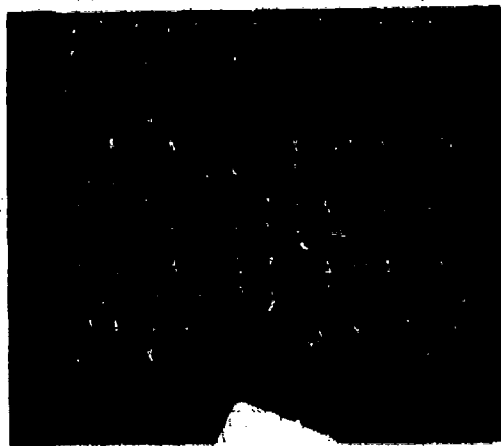
FIGURE D-7. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



8a. MISSILE 11,  $0^\circ$  ROLL,  $10^\circ$  PITCH



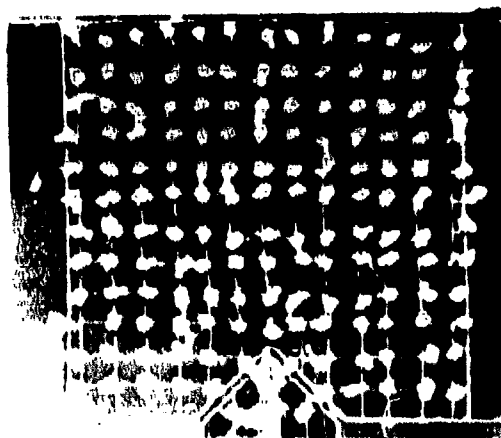
8d. MISSILE 11,  $0^\circ$  ROLL,  $25^\circ$  PITCH



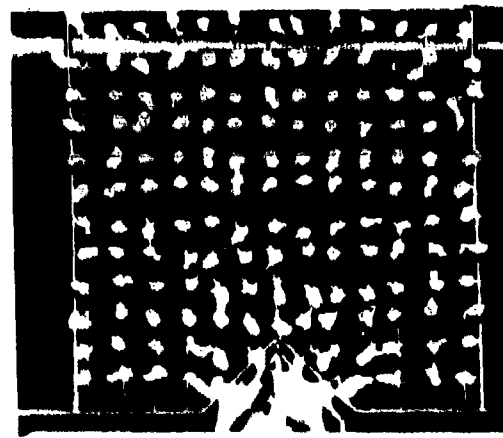
8b. MISSILE 11,  $22^\circ$  ROLL,  $10^\circ$  PITCH



8e. MISSILE 11,  $22^\circ$  ROLL,  $25^\circ$  PITCH

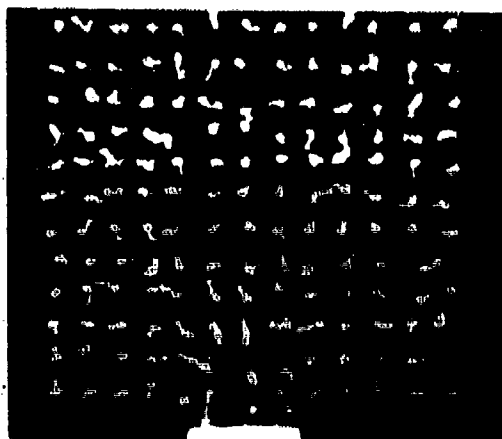


8c. MISSILE 11,  $45^\circ$  ROLL,  $10^\circ$  PITCH

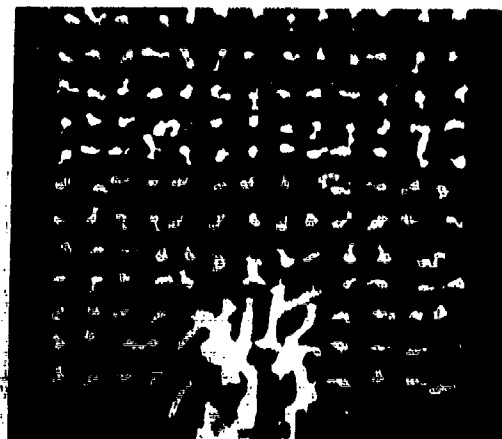


8f. MISSILE 11,  $45^\circ$  ROLL,  $25^\circ$  PITCH

FIGURE D-8. TUFT GRID PHOTOS IN FORWARD PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



9a. MISSILE II,  $0^\circ$  ROLL,  $10^\circ$  PITCH



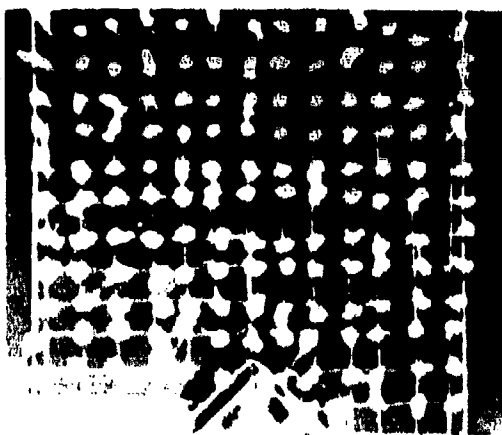
9d. MISSILE II,  $0^\circ$  ROLL,  $25^\circ$  PITCH



9b. MISSILE II,  $22^\circ$  ROLL,  $10^\circ$  PITCH



9e. MISSILE II,  $22^\circ$  ROLL,  $25^\circ$  PITCH

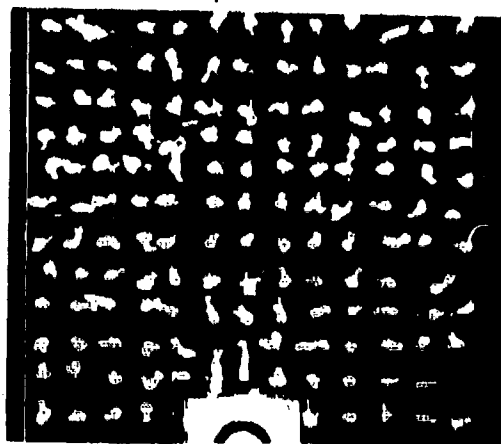


9c. MISSILE II,  $45^\circ$  ROLL,  $10^\circ$  PITCH

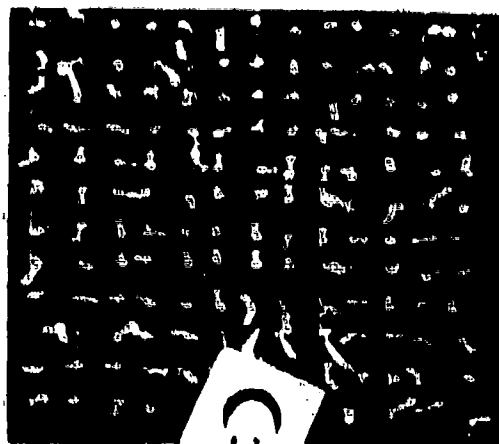


9f. MISSILE II,  $45^\circ$  ROLL,  $25^\circ$  PITCH

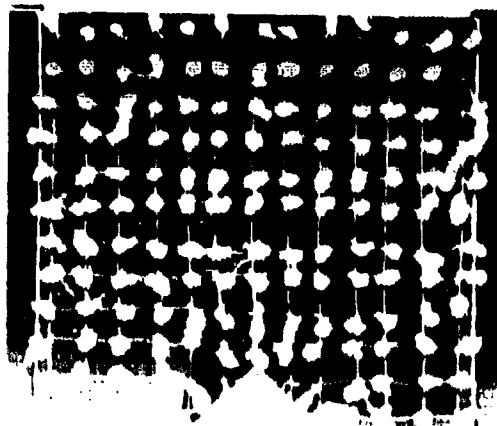
FIGURE D-9. TUFT GRID PHOTOS IN MID PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



10a. MISSILE 11,  $0^\circ$  ROLL,  $10^\circ$  PITCH

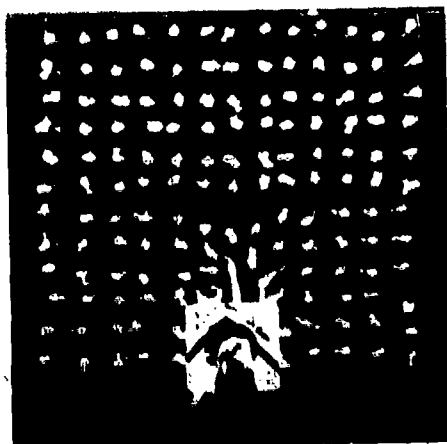


10b. MISSILE 11,  $22^\circ$  ROLL,  $10^\circ$  PITCH

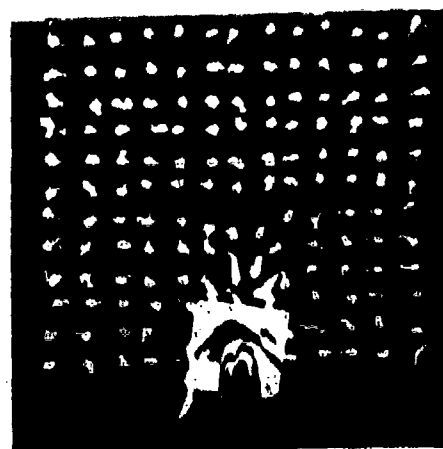


10c. MISSILE 11,  $45^\circ$  ROLL,  $10^\circ$  PITCH

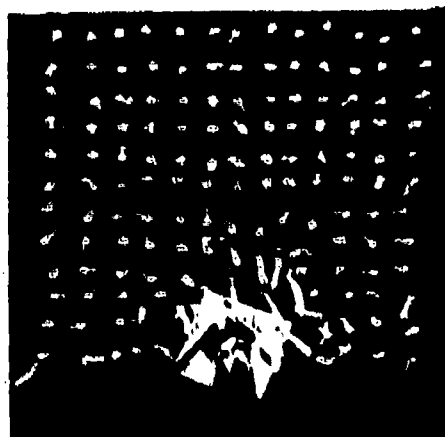
FIGURE D-10. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



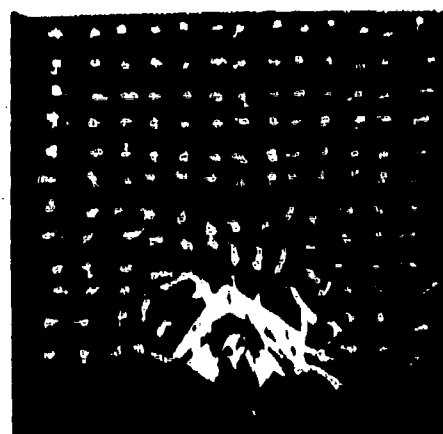
11a. MISSILE 11,  $0^\circ$  ROLL,  $15^\circ$  PITCH



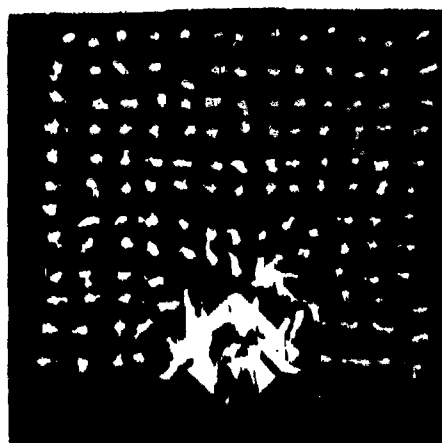
11b. MISSILE 11,  $11^\circ$  ROLL,  $15^\circ$  PITCH



11c. MISSILE 11,  $22^\circ$  ROLL,  $15^\circ$  PITCH



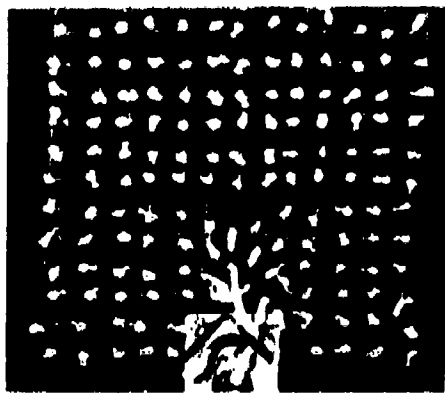
11d. MISSILE 11,  $33^\circ$  ROLL,  $15^\circ$  PITCH



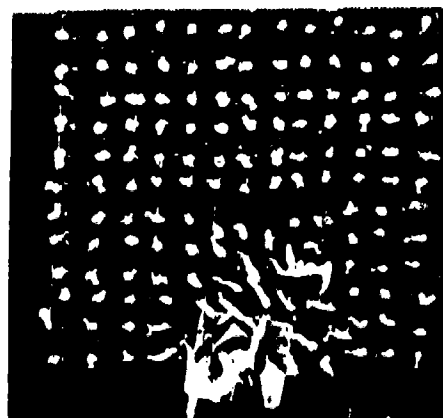
11e. MISSILE 11,  $45^\circ$  ROLL,  $15^\circ$  PITCH

FIGURE D-11. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .

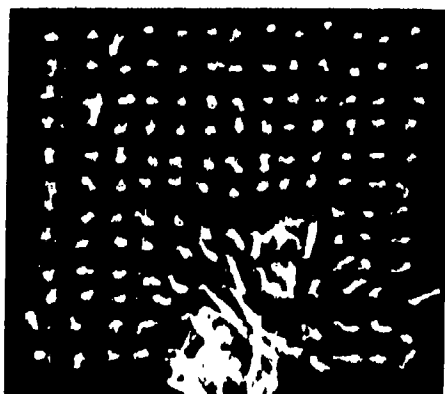




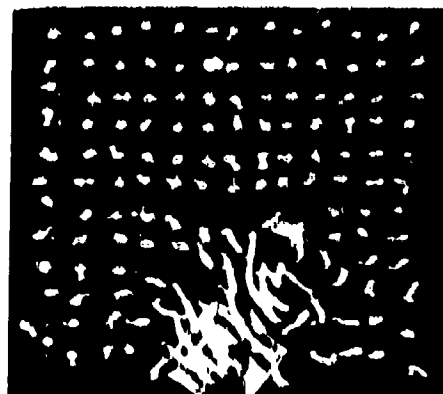
12a. MISSILE 11,  $0^\circ$  ROLL,  $20^\circ$  PITCH



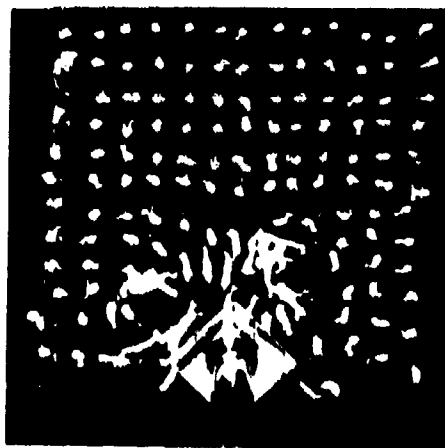
12b. MISSILE 11,  $11^\circ$  ROLL,  $20^\circ$  PITCH



12c. MISSILE 11,  $22^\circ$  ROLL,  $20^\circ$  PITCH



12d. MISSILE 11,  $33^\circ$  ROLL,  $20^\circ$  PITCH

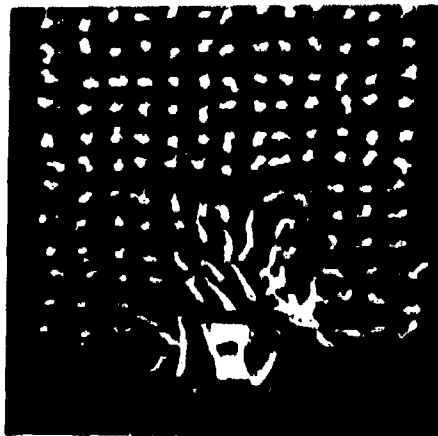


12e. MISSILE 11,  $45^\circ$  ROLL,  $20^\circ$  PITCH

FIGURE D 12. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



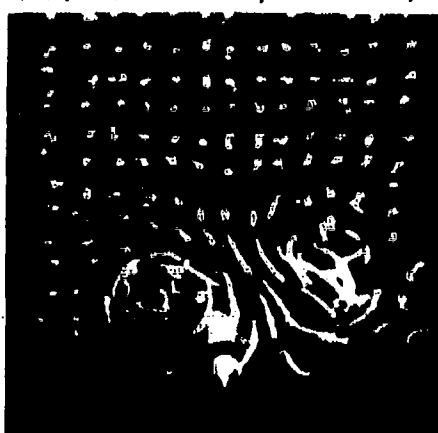
13a. MISSILE 11, 0° ROLL, 25° PITCH



13b. MISSILE 11, 11° ROLL, 25° PITCH



13c. MISSILE 11, 22° ROLL, 25° PITCH

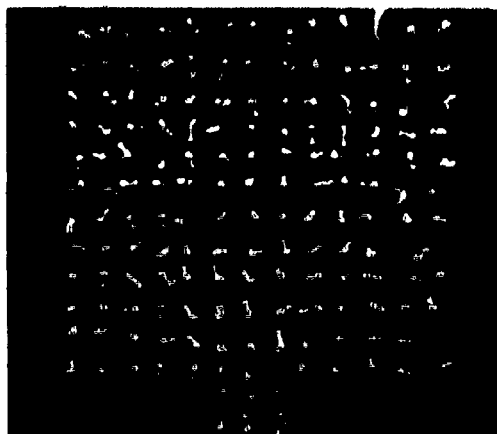


13d. MISSILE 11, 33° ROLL, 25° PITCH

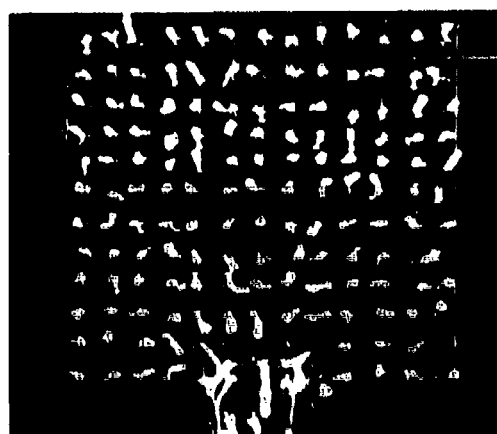


13e. MISSILE 11, 45° ROLL, 25° PITCH

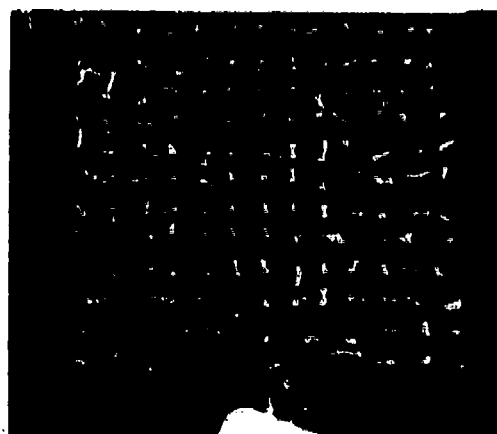
FIGURE D-13 TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



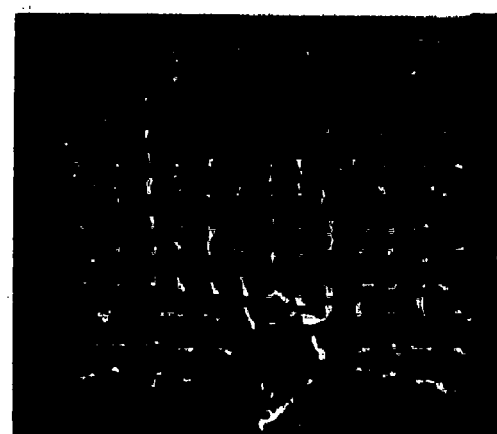
14a. MISSILE III,  $0^\circ$  ROLL,  $10^\circ$  PITCH



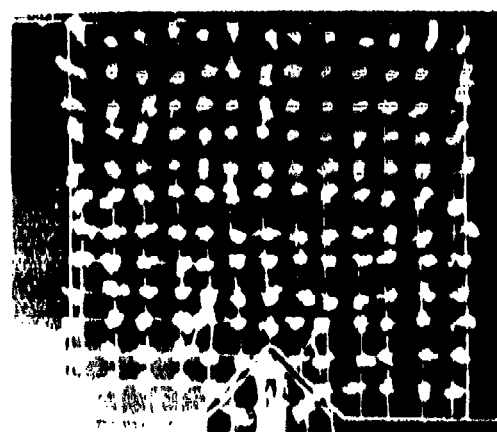
14d. MISSILE III,  $0^\circ$  ROLL,  $25^\circ$  PITCH



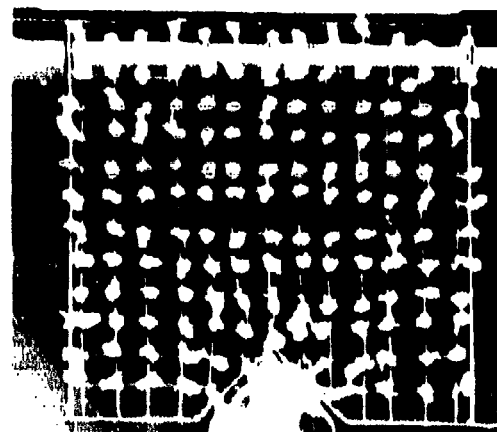
14b. MISSILE III,  $22^\circ$  ROLL,  $10^\circ$  PITCH



14e. MISSILE III,  $22^\circ$  ROLL,  $25^\circ$  PITCH

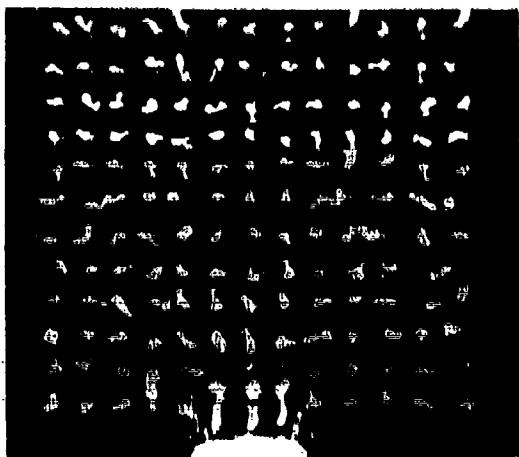


14c. MISSILE III,  $45^\circ$  ROLL,  $10^\circ$  PITCH

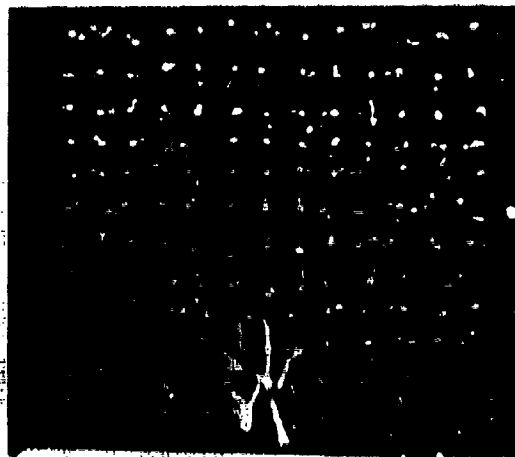


14f. MISSILE III,  $45^\circ$  ROLL,  $25^\circ$  PITCH

FIGURE D-14. TUFT GRID PHOTOS IN FORWARD PLANE  
FOR MISSILE OF FINENESS RATIO 7.5



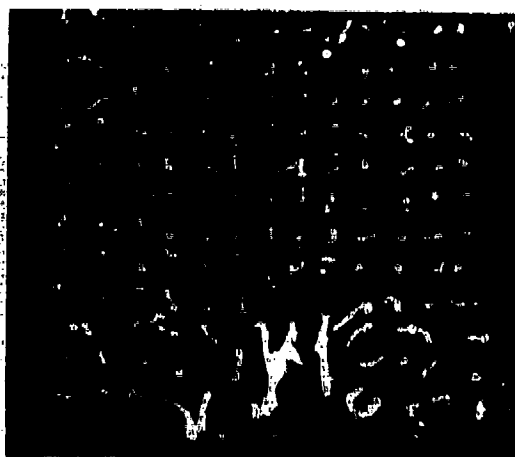
15a. MISSILE III, 0° ROLL, 10° PITCH



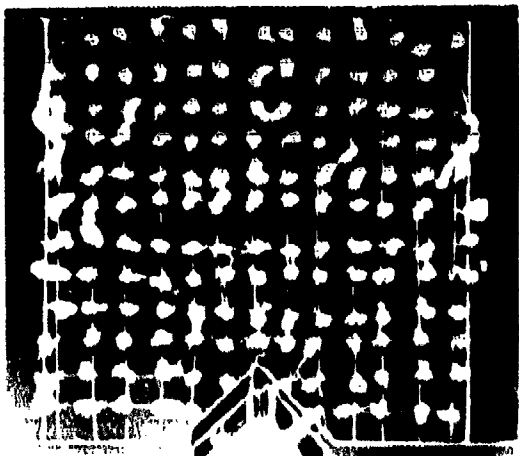
15d. MISSILE III, 0° ROLL, 25° PITCH



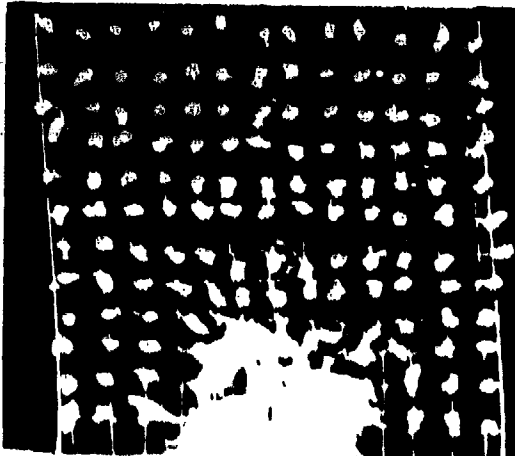
15b. MISSILE III, 22° ROLL, 10° PITCH



15e. MISSILE III, 22° ROLL, 25° PITCH

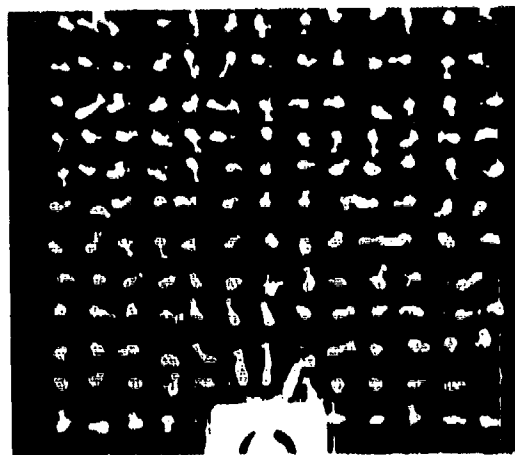


15c. MISSILE III, 45° ROLL, 10° PITCH

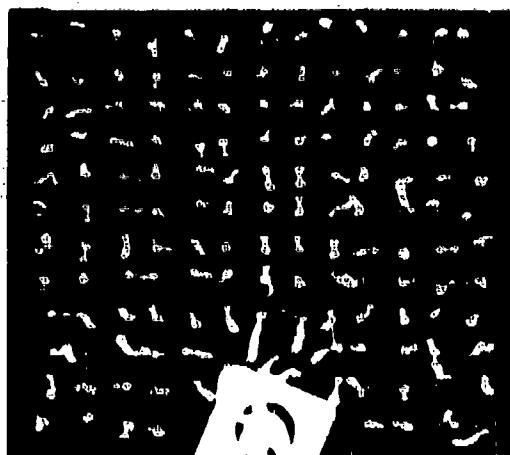


15f. MISSILE III, 45° ROLL, 25° PITCH

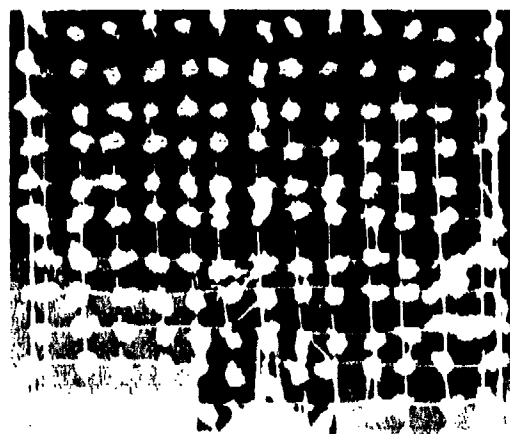
FIGURE D-15 TUFT GRID PHOTOS IN MID PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



16a. MISSILE III,  $0^\circ$  ROLL,  $10^\circ$  PITCH

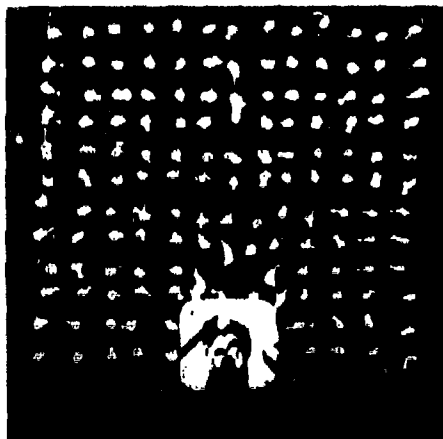


16b. MISSILE III,  $22^\circ$  ROLL,  $10^\circ$  PITCH

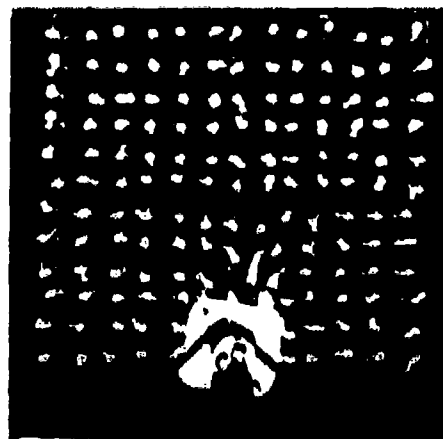


16c. MISSILE III,  $45^\circ$  ROLL,  $10^\circ$  PITCH

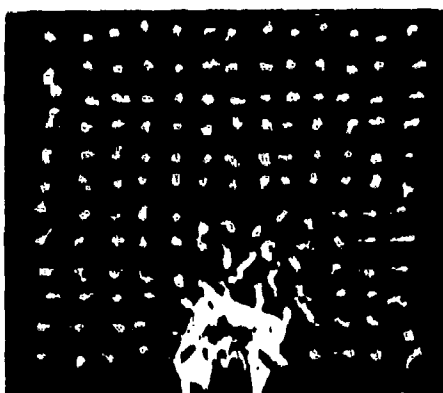
FIGURE D-16. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5 .



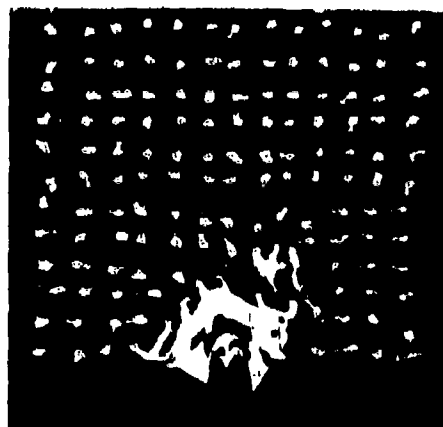
17a. MISSILE 111,  $0^\circ$  ROLL,  $15^\circ$  PITCH



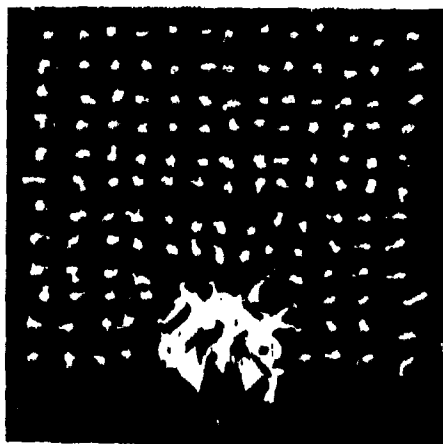
17b. MISSILE 111,  $11^\circ$  ROLL,  $15^\circ$  PITCH



17c. MISSILE 111,  $22^\circ$  ROLL,  $15^\circ$  PITCH

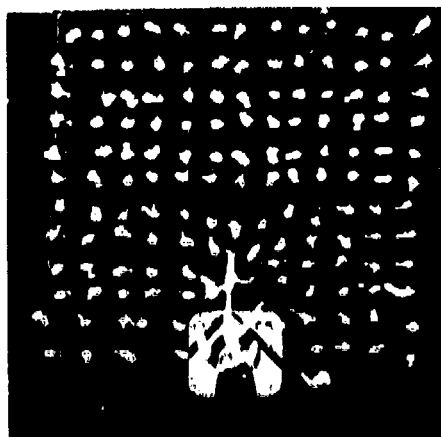


17d. MISSILE 111,  $33^\circ$  ROLL,  $15^\circ$  PITCH

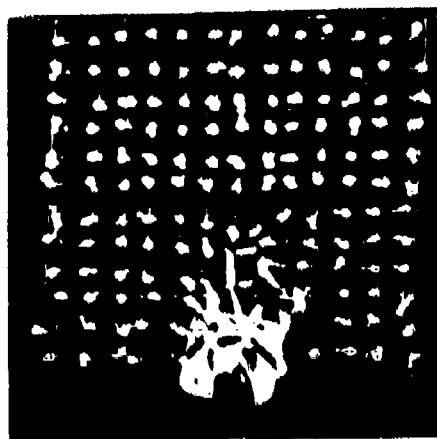


17e. MISSILE 111,  $45^\circ$  ROLL,  $15^\circ$  PITCH

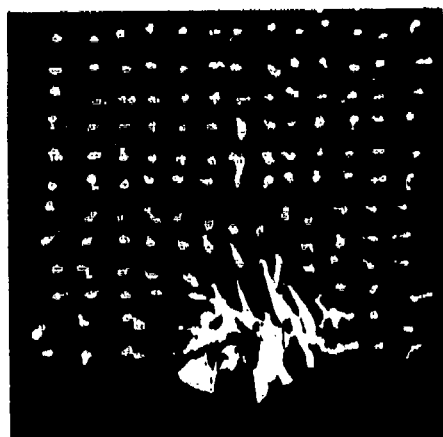
FIGURE D-17 TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5



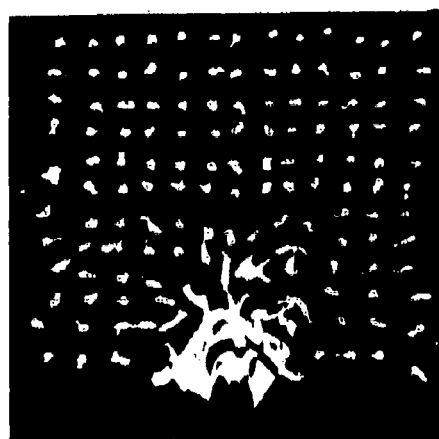
18a. MISSILE III,  $0^\circ$  ROLL,  $20^\circ$  PITCH



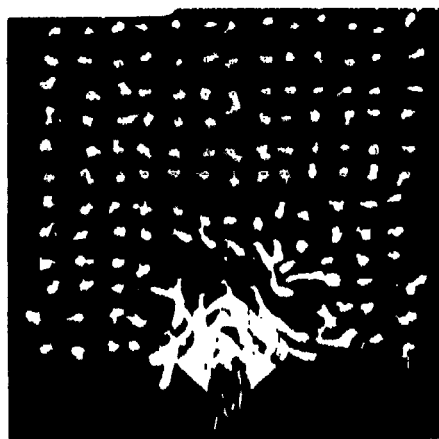
18b. MISSILE III,  $11^\circ$  ROLL,  $20^\circ$  PITCH



18c. MISSILE III,  $22^\circ$  ROLL,  $20^\circ$  PITCH

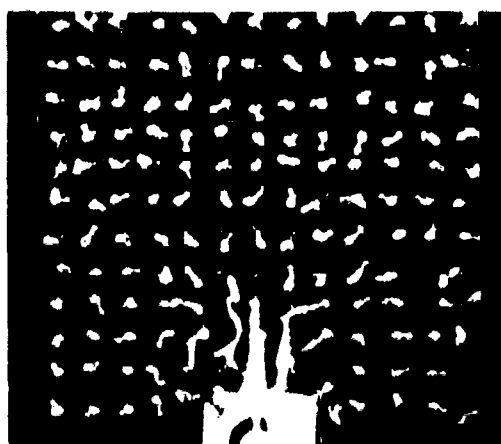


18d. MISSILE III,  $33^\circ$  ROLL,  $20^\circ$  PITCH

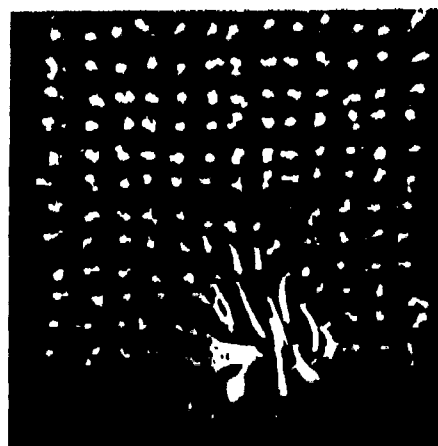


18e. MISSILE III,  $45^\circ$  ROLL,  $20^\circ$  PITCH

FIGURE D-18. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 7.5



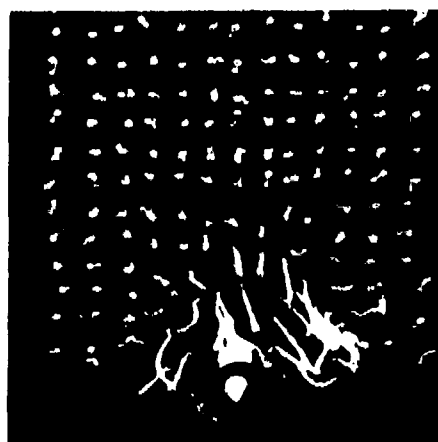
19a. MISSILE III,  $0^{\circ}$  ROLL,  $25^{\circ}$  PITCH



19b. MISSILE III,  $11^{\circ}$  ROLL,  $25^{\circ}$  PITCH



19c. MISSILE III,  $22^{\circ}$  ROLL,  $25^{\circ}$  PITCH



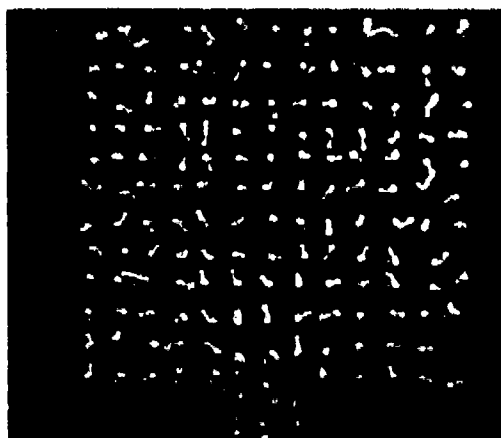
19d. MISSILE III,  $33^{\circ}$  ROLL,  $25^{\circ}$  PITCH



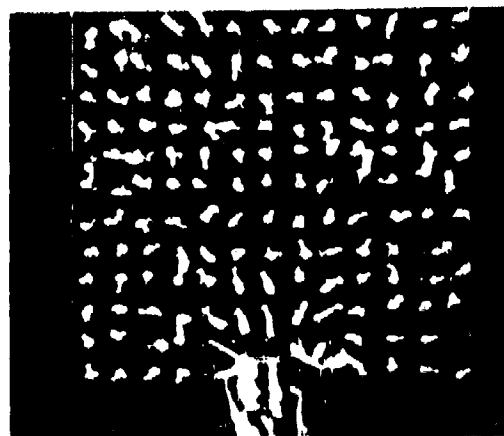
19e. MISSILE III,  $45^{\circ}$  ROLL,  $25^{\circ}$  PITCH

FIGURE D-19. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FITNESS RATIO 7.5

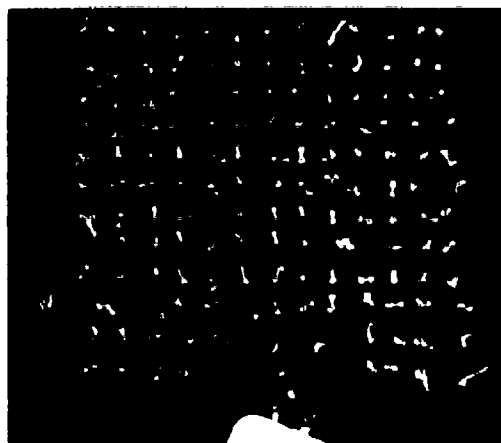




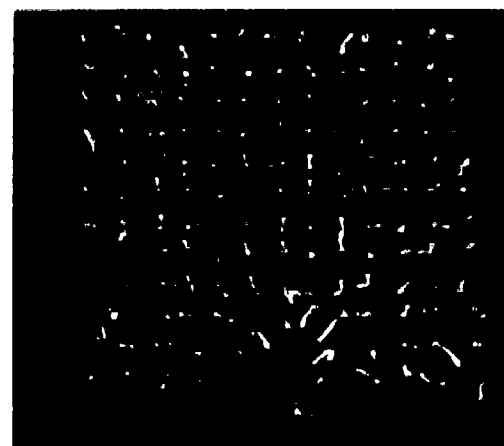
194. MISSILE TEL, 0° ROLL, 0° PITCH, 0° YAW



195. MISSILE TEL, 0° ROLL, 0° PITCH, 0° YAW



196. MISSILE TEL, 0° ROLL, 0° PITCH, 0° YAW



197. MISSILE TEL, 0° ROLL, 0° PITCH, 0° YAW

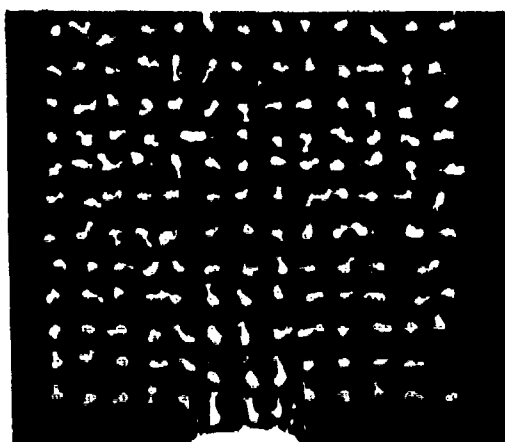


198. MISSILE TEL, 0° ROLL, 0° PITCH, 0° YAW

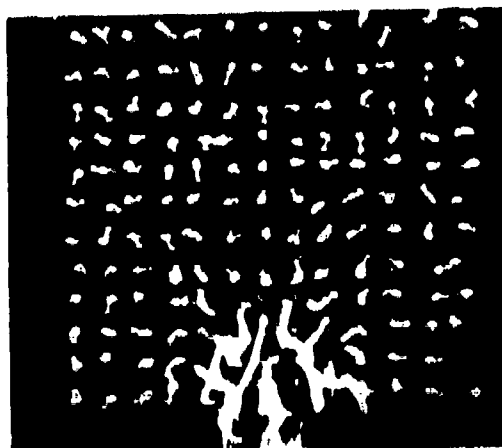


199. MISSILE TEL, 0° ROLL, 0° PITCH, 0° YAW

FIGURE D-20. TUFT GRID PHOTOS IN FORWARD PLANE  
FOR MISSILE OF LENGTH RATIO 1.0



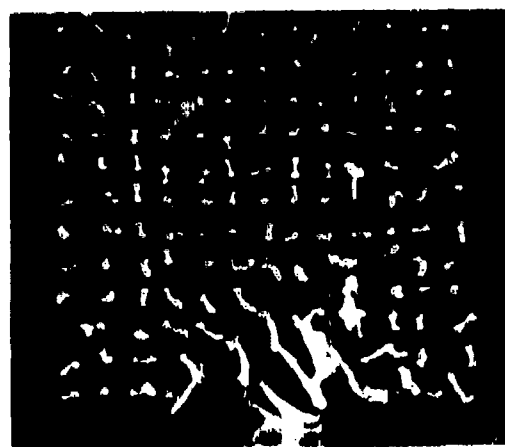
214. MISSILE 111, 0° ROLL, 10° PITCH, PL. NOSE



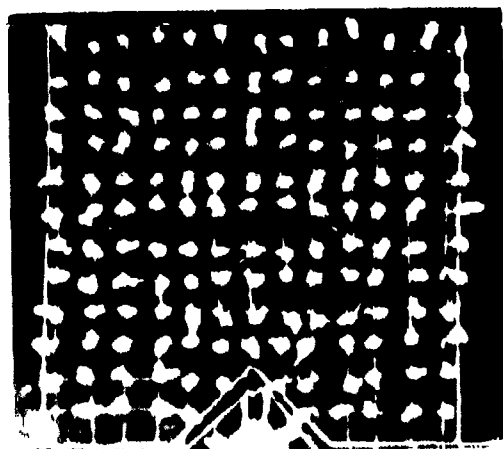
215. MISSILE 111, 0° ROLL, 25° PITCH, PL. NOSE



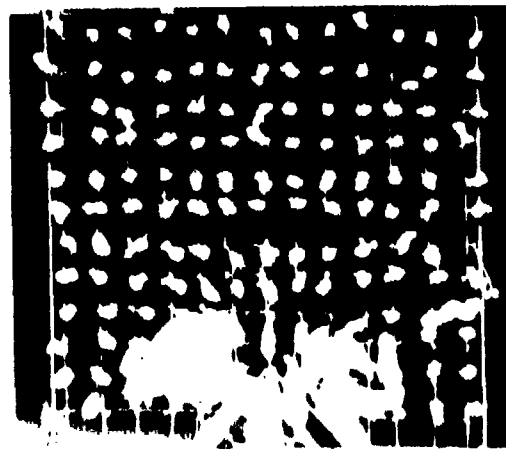
216. MISSILE 111, 22° ROLL, 10° PITCH, PL. NOSE



217. MISSILE 111, 22° ROLL, 25° PITCH, PL. NOSE

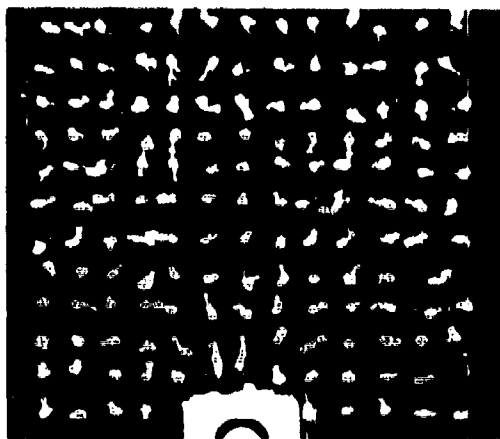


218. MISSILE 111, 45° ROLL, 10° PITCH, PL. NOSE

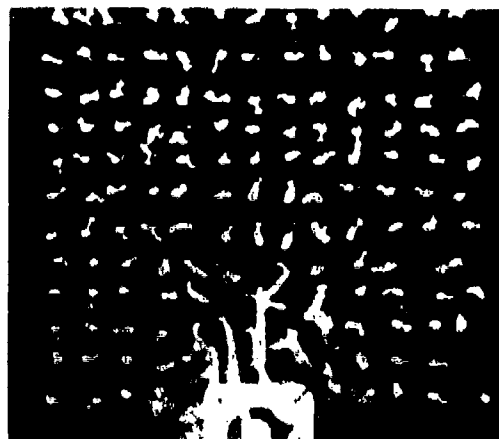


219. MISSILE 111, 45° ROLL, 25° PITCH, PL. NOSE

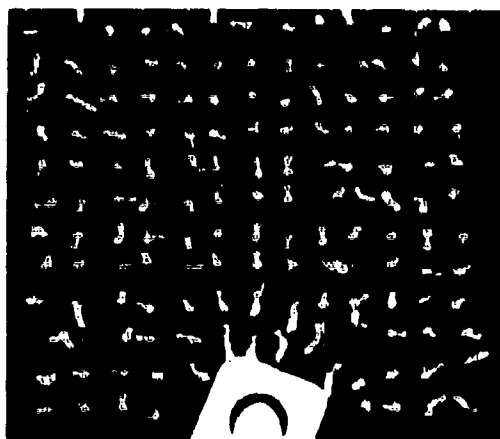
FIGURE D-21. TUFT GRID PHOTOS IN MID PLANE  
FOR MISSILE OF FINENESS RATIO 3.0 .



22a. MISSILE 111,  $0^\circ$  ROLL,  $10^\circ$  PITCH, PL. NOSE



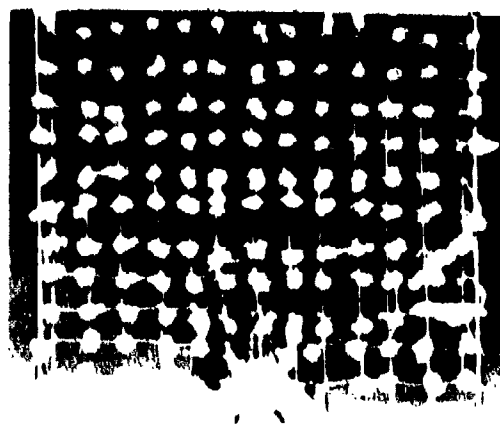
22b. MISSILE 111,  $0^\circ$  ROLL,  $25^\circ$  PITCH, PL. NOSE



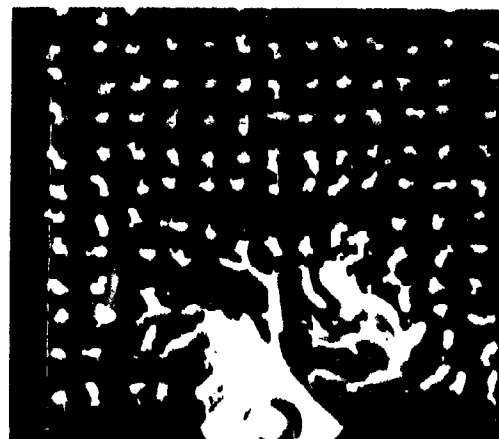
22c. MISSILE 111,  $2^\circ$  ROLL,  $10^\circ$  PITCH, PL. NOSE



22d. MISSILE 111,  $2^\circ$  ROLL,  $25^\circ$  PITCH, PL. NOSE

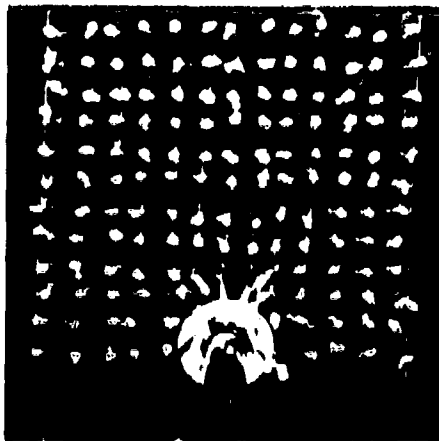


22e. MISSILE 111,  $10^\circ$  ROLL,  $10^\circ$  PITCH, PL. NOSE

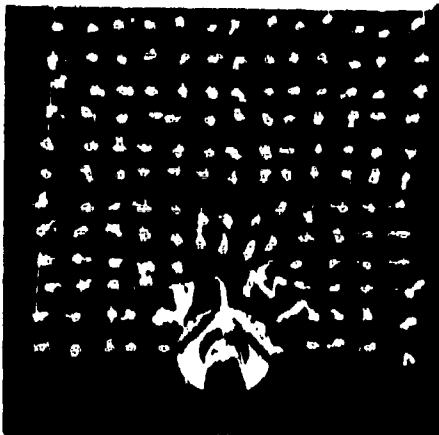


22f. MISSILE 111,  $10^\circ$  ROLL,  $25^\circ$  PITCH, PL. NOSE

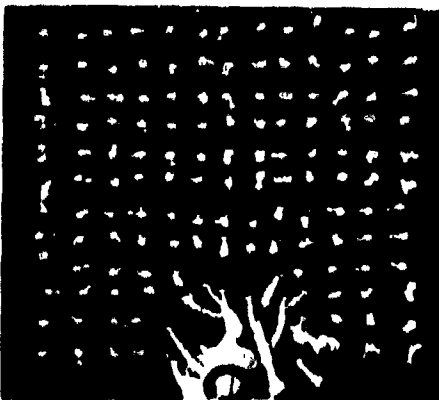
FIGURE D-22. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 8.0



23a. MISSILE IV,  $0^\circ$  ROLL,  $15^\circ$  PITCH

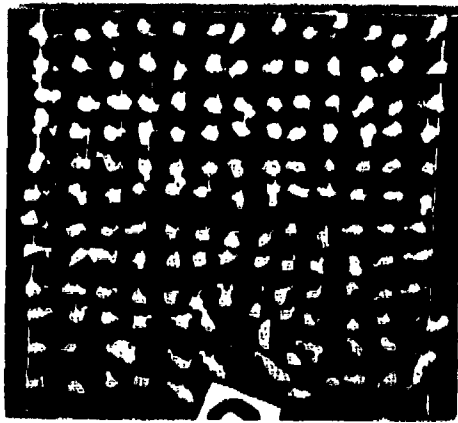


23b. MISSILE IV,  $0^\circ$  ROLL,  $20^\circ$  PITCH

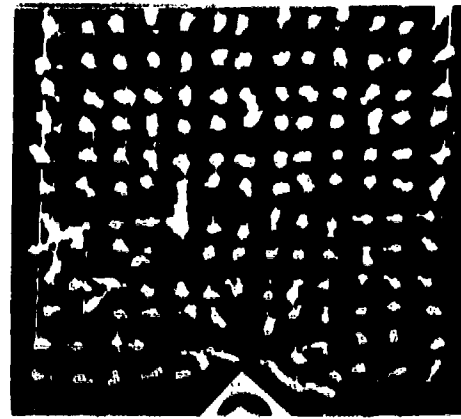


23c. MISSILE IV,  $0^\circ$  ROLL,  $25^\circ$  PITCH

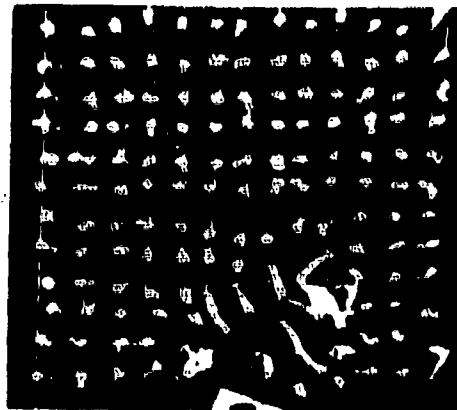
FIGURE D-23. TARGETED PHOTOS IN AIR PLANE  
FOR MISSILE OF TYPE 25 AT 10-7.5.



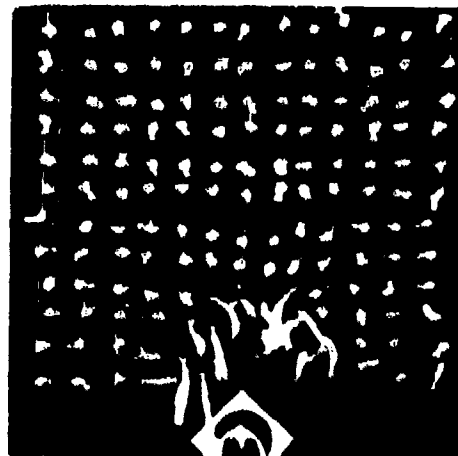
24a. MISSILE 1,  $22^\circ$  ROLL,  $10^\circ$  PITCH



24b. MISSILE 1,  $45^\circ$  ROLL,  $10^\circ$  PITCH



24c. MISSILE 1,  $22^\circ$  ROLL,  $15^\circ$  PITCH

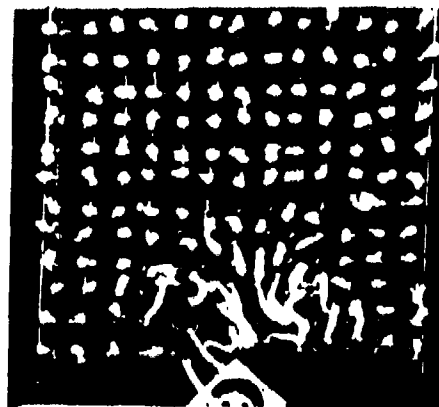


24d. MISSILE 1,  $45^\circ$  ROLL,  $15^\circ$  PITCH

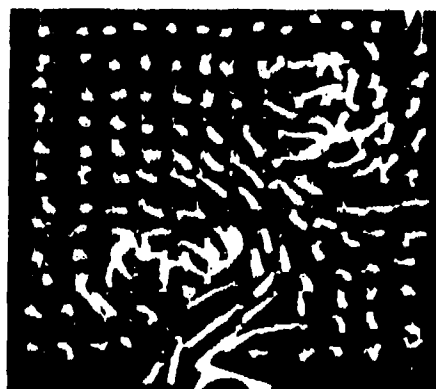
FIGURE D-24. TUFT GRID PHOTOS IN ALT PLANE  
FOR MISSILE OF FINENESS RATIO 15.33



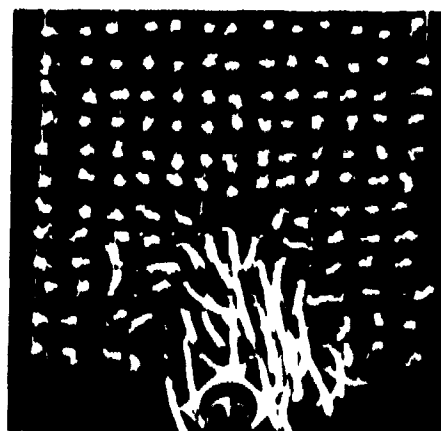
25a. MISSILE 1,  $22^{\circ}$  ROLL,  $20^{\circ}$  PITCH



25b. MISSILE 1,  $45^{\circ}$  ROLL,  $20^{\circ}$  PITCH

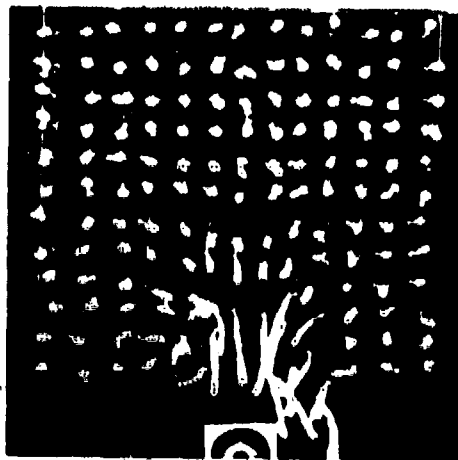


25c. MISSILE 1,  $33^{\circ}$  ROLL,  $25^{\circ}$  PITCH



25d. MISSILE 1,  $45^{\circ}$  ROLL,  $35^{\circ}$  PITCH

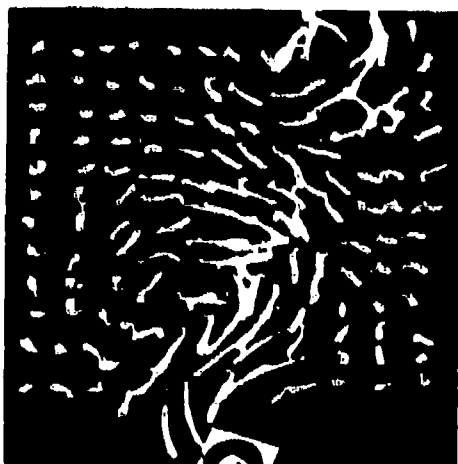
FIGURE D 25. 1001 GRID PHOTOS IN ALL PLANE  
FOR MISSILE OF CRUCIAL-MAILED TYPE



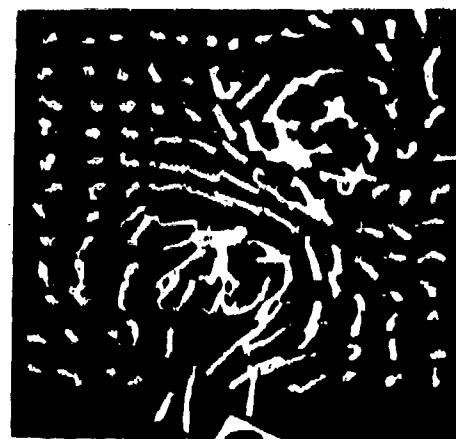
26a. MISSILE 1,  $0^\circ$  ROLL,  $30^\circ$  PITCH



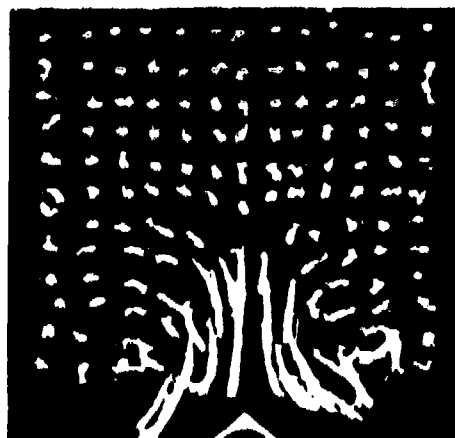
26b. MISSILE 1,  $11^\circ$  ROLL,  $30^\circ$  PITCH



26c. MISSILE 1,  $22^\circ$  ROLL,  $30^\circ$  PITCH

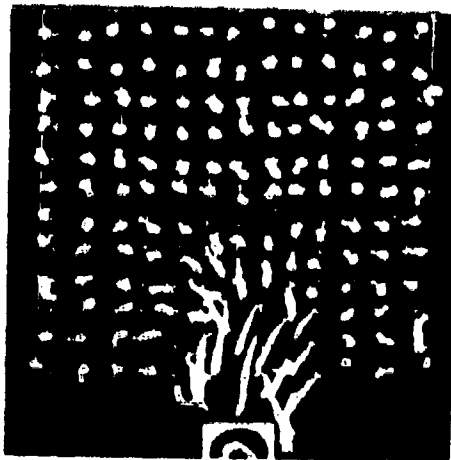


26d. MISSILE 1,  $33^\circ$  ROLL,  $30^\circ$  PITCH

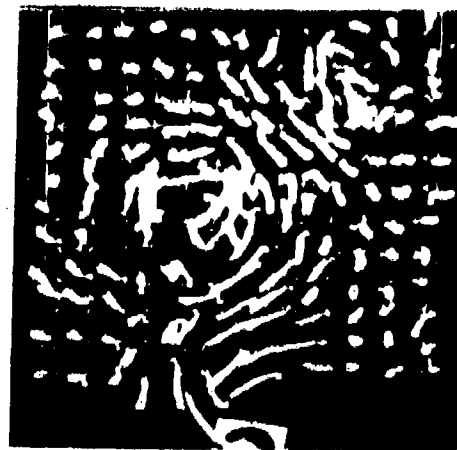


26e. MISSILE 1,  $45^\circ$  ROLL,  $30^\circ$  PITCH

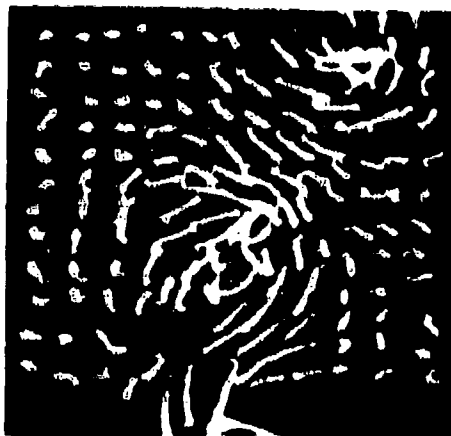
FIGURE D-26. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 15.33



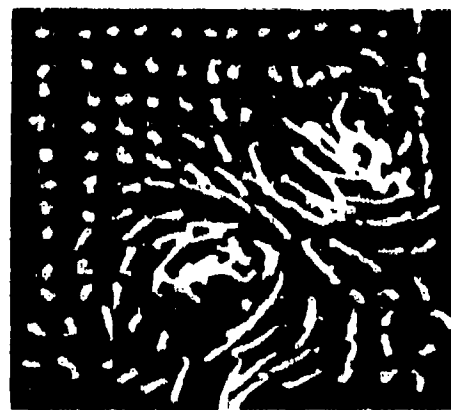
27a. MISSILE 2,  $0^\circ$  ROLL,  $30^\circ$  PITCH



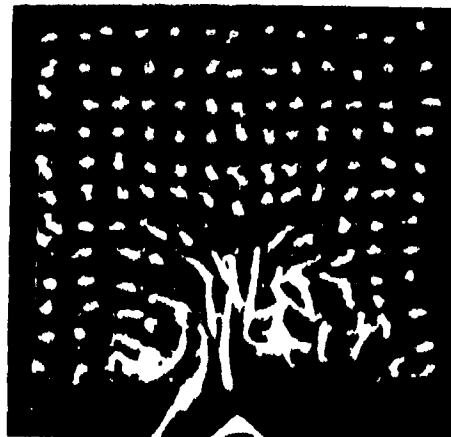
27b. MISSILE 2,  $11^\circ$  ROLL,  $30^\circ$  PITCH



27c. MISSILE 2,  $22^\circ$  ROLL,  $30^\circ$  PITCH



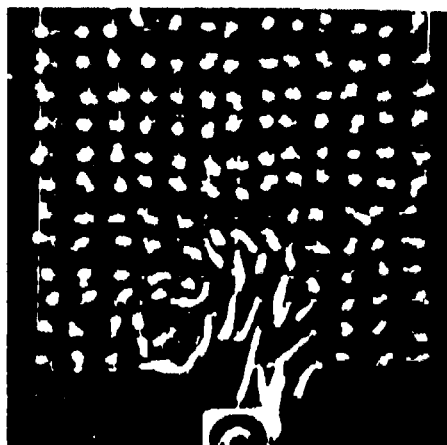
27d. MISSILE 2,  $33^\circ$  ROLL,  $30^\circ$  PITCH



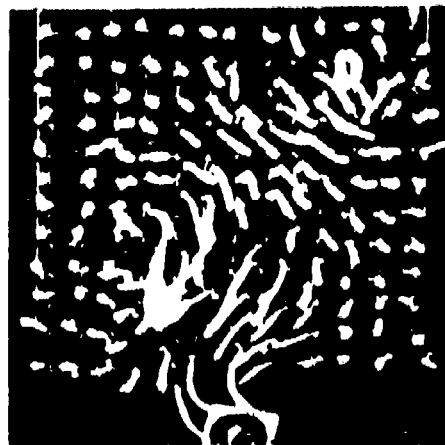
27e. MISSILE 2,  $45^\circ$  ROLL,  $30^\circ$  PITCH

FIGURE D 27. TILT GRID PHOTOS TO APPEARANCE  
FOR MISSILE OF FINNESS RATIO 1.0





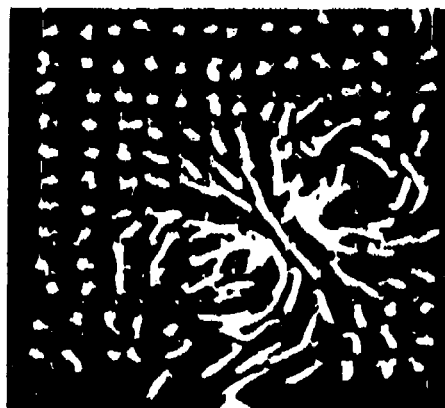
28a. MISSILE 2,  $0^{\circ}$  ROLL,  $30^{\circ}$  PITCH



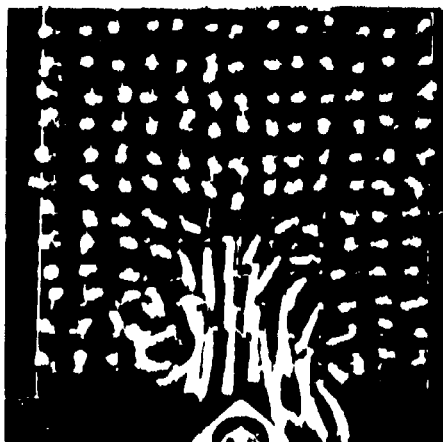
28b. MISSILE 3,  $11^{\circ}$  ROLL,  $30^{\circ}$  PITCH



28c. MISSILE 3,  $22^{\circ}$  ROLL,  $30^{\circ}$  PITCH



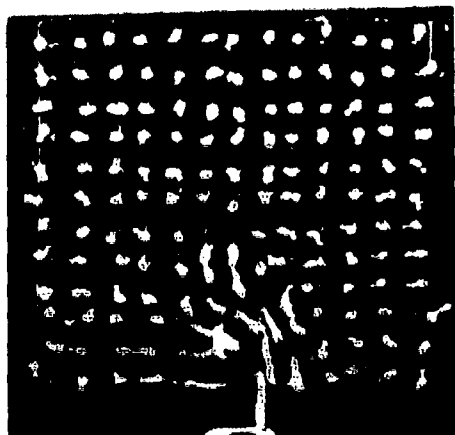
28d. MISSILE 3,  $33^{\circ}$  ROLL,  $30^{\circ}$  PITCH



28e. MISSILE 3,  $45^{\circ}$  ROLL,  $30^{\circ}$  PITCH

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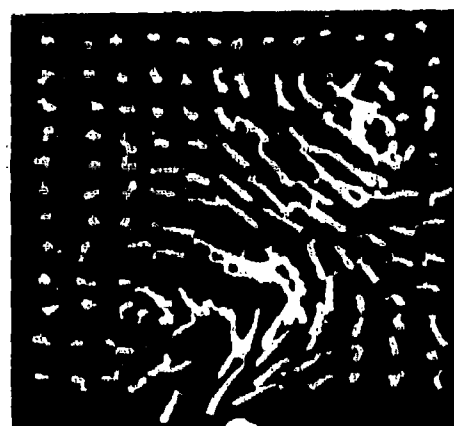
29a. MISSILE 4,  $0^\circ$  ROLL,  $30^\circ$  PITCH



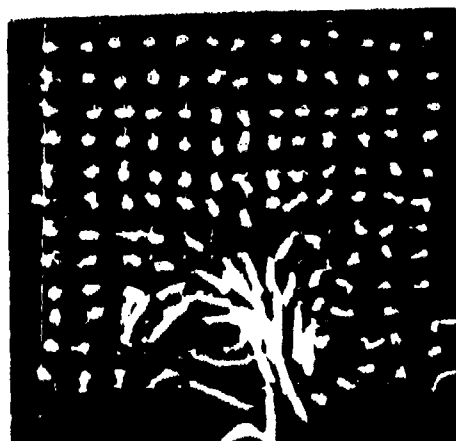
29b. MISSILE 4,  $11^\circ$  ROLL,  $30^\circ$  PITCH



29c. MISSILE 4,  $22^\circ$  ROLL,  $30^\circ$  PITCH

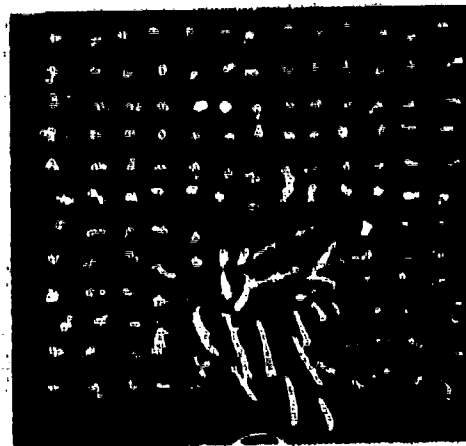


29d. MISSILE 4,  $33^\circ$  ROLL,  $30^\circ$  PITCH



29e. MISSILE 4,  $45^\circ$  ROLL,  $30^\circ$  PITCH

FIGURE D-29. LEFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 15.33 .



30a. MISSILE 5,  $0^\circ$  ROLL,  $30^\circ$  PITCH

FIGURE D-30. TUFT GRID PHOTOS IN AFT PLANE  
FOR MISSILE OF FINENESS RATIO 15.33 .

## APPENDIX E

### OIL FLOW PATTERNS

Oil flow tests were conducted on missiles of fineness ratio 8 and 16 in the subsonic wind tunnel at a freestream velocity of 360 fps. Photographs were recorded of the oil patterns for the missiles tested at various configurations and orientations and are illustrated in Figures E-1 through E-41. All tests were conducted of missiles without fins.

Oil flow tests were conducted as follows. After painting the models black, a white oil (mixture of titanium dioxide, oleic acid and 90 weight transmission oil) was sprayed in a speckled pattern on the surface of each model. The models were placed on the sting, and the wind tunnel was run for approximately 2 minutes--the time required for the oil to migrate over the surface of the models. Photographs of the upper, right and left sides of the models were then taken for the various missile configurations and orientations tested.

For missiles of fineness ratio 8, each of the 4 bodies was tested with the blunt nose at 10, 15, 20, and 25 degrees pitch and 0, 11, 22, 33, and 45 degrees roll. The 20% corner radius body was also tested with the pointed nose at 10, 15, 20, and 25 degrees

pitch and 0, 22, and 45 degrees roll. A test matrix of the various missile configurations and orientations is shown in Table E-1.

For missiles of fineness ratio 16, each of the 5 bodies was tested with the blunt nose at 30 degrees pitch and 0 and 22 degrees roll. In addition, the 20% corner radius body was also tested at 30 degrees pitch and 11, 33, and 45 degrees roll. Table E-2 shows the configurations and orientations tested for missiles of fineness ratio 16.

Figures E-1 and E-41 show oil flow patterns on the top, left and right surfaces for the various missile configurations and orientations tested. Each of the three views (top, left, and right) of the model are defined looking upstream. However, at the completion of each test to facilitate the photography, the models were rolled 90 degrees and 180 degrees prior to taking photographs of the top and right views, respectively. To help eliminate confusion, a schematic of the cross-flow plane during the experiment and during the photography is shown on Figure E.01.

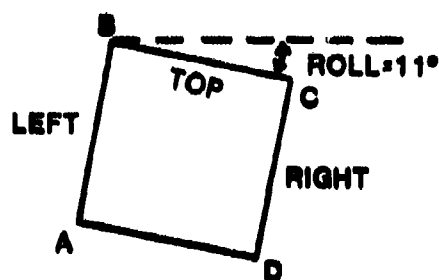


Figure E.01A.

Position of Model at 11 Degrees Roll During Wind Tunnel Experiment ( $\phi = 11$  Degrees)

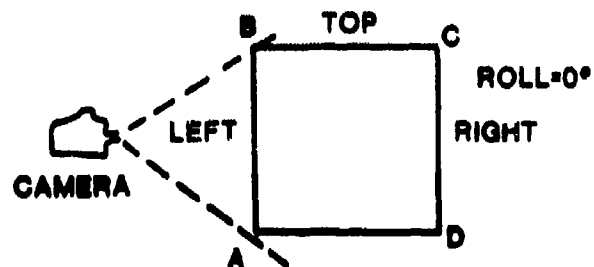


Figure E.01B.

Position of Model during Photography of Left Side ( $\phi = 0$  Degrees)

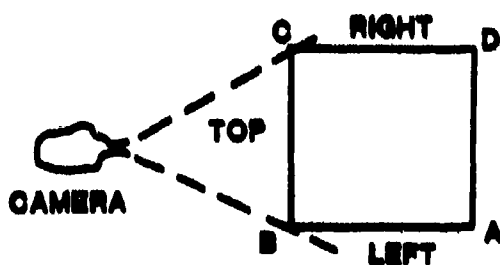


Figure E.01C.

Position of Model during Photography of Top Side ( $\phi = -90$  Degrees)

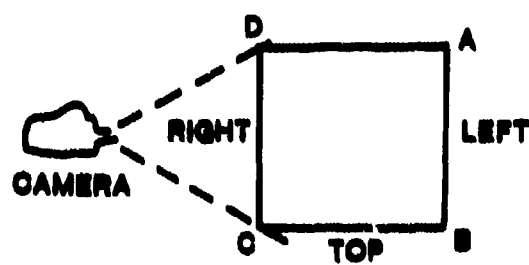


Figure E.01D.

Position of Model during Photography of Right Side ( $\phi = -180$  Degrees)

Figure E.01. Positions of Missile During Wind Tunnel Experiments and Photography. View Looking Upstream (at Aft End of Missile)

TABLE E-1

## OIL FLOW PATTERNS FOR MISSILES OF FINENESS RATIO 8

| Body Configuration | Nose Shape | Pitch Angle | Roll Angle | Figure |
|--------------------|------------|-------------|------------|--------|
| I                  | BL         | 10°, 15°    | 0°         | E-1    |
| I                  | BL         | 20°, 25°    | 0°         | E-2    |
| I                  | BL         | 15°, 20°    | 11°        | E-3    |
| I                  | BL         | 10°, 25°    | 11°        | E-4    |
| I                  | BL         | 15°, 20°    | 22°        | E-5    |
| I                  | BL         | 25°, 15°    | 22°, 33°   | E-6    |
| I                  | BL         | 20°, 25°    | 33°        | E-7    |
| I                  | BL         | 10°, 15°    | 45°        | E-8    |
| I                  | BL         | 20°, 25°    | 45°        | E-9    |
| II                 | BL         | 10°, 15°    | 0°         | E-10   |
| II                 | BL         | 20°, 25°    | 0°         | E-11   |
| II                 | BL         | 15°, 20°    | 11°        | E-12   |
| II                 | BL         | 25°, 10°    | 11°, 22°   | E-13   |
| II                 | BL         | 15°, 20°    | 22°        | E-14   |
| II                 | BL         | 25°, 15°    | 22°, 33°   | E-15   |
| II                 | BL         | 20°, 25°    | 33°        | E-16   |
| II                 | BL         | 10°, 15°    | 45°        | E-17   |
| II                 | BL         | 20°, 25°    | 45°        | E-18   |
| III                | BL         | 10°, 15°    | 0°         | E-19   |
| III                | BL         | 20°, 25°    | 0°         | E-20   |
| III                | BL         | 15°, 20°    | 11°        | E-21   |
| III                | BL         | 25°, 10°    | 11°, 22°   | E-22   |

TABLE E-1

## OIL FLOW PATTERNS FOR MISSILES OF FINENESS RATIO 8

| Body*<br>Configuration | Nose**<br>Shape | Pitch<br>Angle | Roll<br>Angle | Figure |
|------------------------|-----------------|----------------|---------------|--------|
| III                    | BL              | 15°, 20°       | 22°           | E-23   |
| III                    | BL              | 25°, 15°       | 22°, 33°      | E-24   |
| III                    | BL              | 20°, 25°       | 33°           | E-25   |
| III                    | BL              | 10°, 15°       | 45°           | E-26   |
| III                    | BL              | 20°, 25°       | 45°           | E-27   |
| IV                     | BL              | 10°, 15°       | 0°            | E-28   |
| IV                     | BL              | 20°, 25°       | 0°            | E-29   |
| III                    | PT              | 20°, 25°       | 0°            | E-30   |
| III                    | PT              | 10°, 15°       | 0°            | E-31   |
| III                    | PT              | 10°, 15°       | 22°           | E-32   |
| III                    | PT              | 20°, 25°       | 22°           | E-33   |
| III                    | PT              | 10°, 15°       | 45°           | E-34   |
| III                    | PT              | 20°, 25°       | 45°           | E-35   |

## \*Body Shapes

- I - Square
- II - 10% Corner Radius
- III - 20% Corner Radius
- IV - Round

## \*\*Nose Shapes

- BL - Blunt Nose
- PT - Pointed Nose



TABLE E-2  
OIL FLOW PATTERNS FOR MISSILES OF FINENESS RATIO 16

| Body <sup>†</sup><br>Configuration | Nose <sup>†</sup><br>Shape | Pitch<br>Angle | Roll<br>Angle | Figure |
|------------------------------------|----------------------------|----------------|---------------|--------|
| 1                                  | ML                         | 30°            | 0°, 22°       | E-36   |
| 2                                  | ML                         | 30°            | 0°, 22°       | E-37   |
| 3                                  | ML                         | 30°            | 0°, 11°       | E-38   |
| 3                                  | ML                         | 30°            | 22°, 33°      | E-39   |
| 3,4                                | ML                         | 30°            | 45°, 0°       | E-40   |
| 4,5                                | ML                         | 30°            | 22°, 0°       | E-41   |

<sup>†</sup>Body Configuration

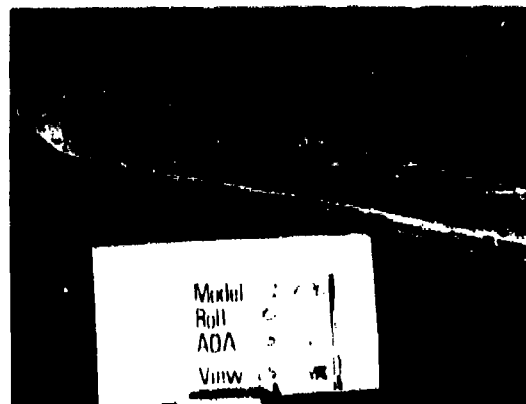
- 1 - Square
- 2 - 10% Corner Radius
- 3 - 20% Corner Radius
- 4 - 30% Corner Radius
- 5 - Round

<sup>††</sup>Nose Shape

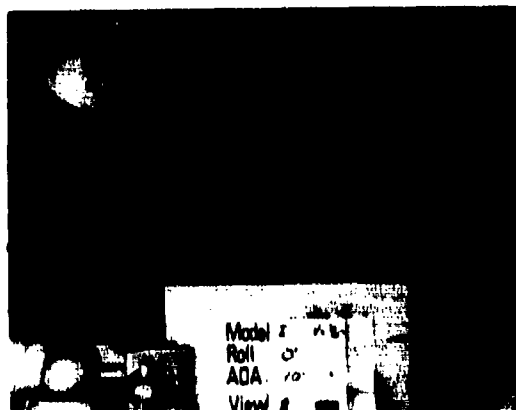
- ML - Blunt Nose
- PT - Pointed Nose



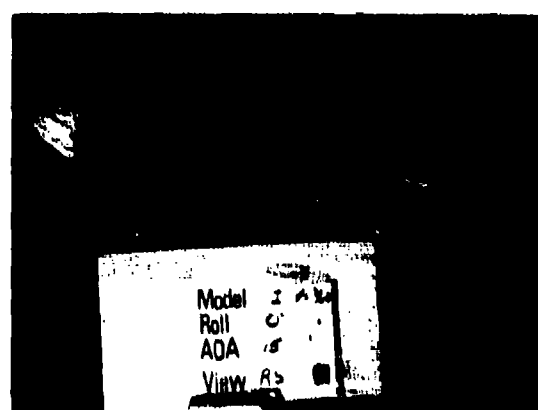
1a. PICTURE A- LEFT SIDE VIEW



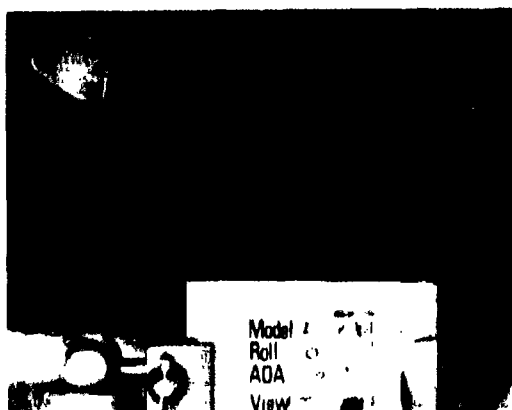
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

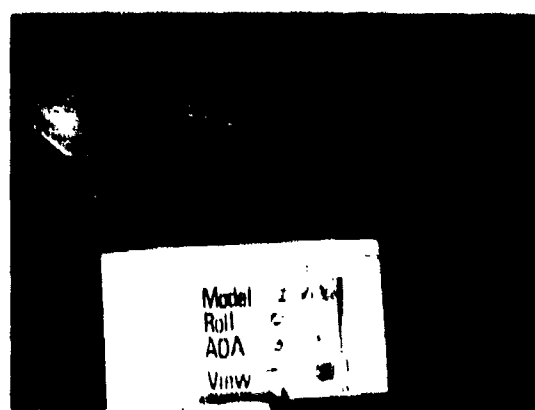


2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOP SIDE VIEW

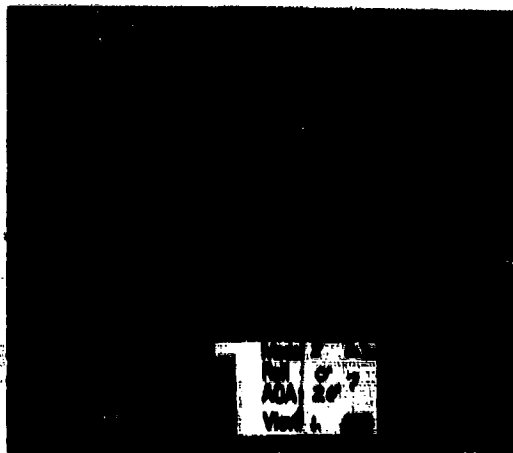
COLUMN 1, MISSILE 1, OF ROLL, TOP AOA.



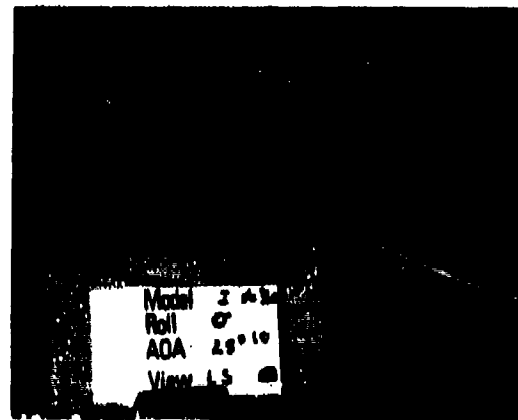
2c. PICTURE F- TOP SIDE VIEW

COLUMN 2, MISSILE 1, OF ROLL, TOP AOA.

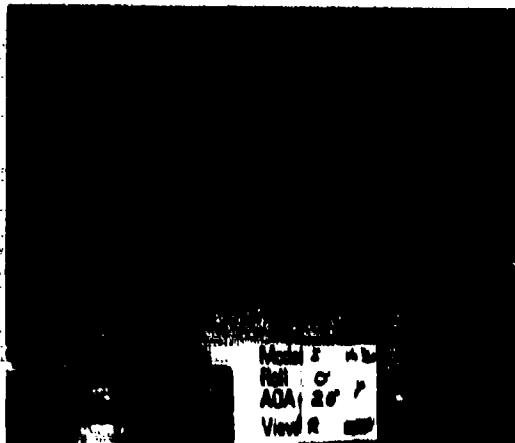
FIGURE E-1. OIL FLOW VISUALIZATION PHOTOGRAPH.



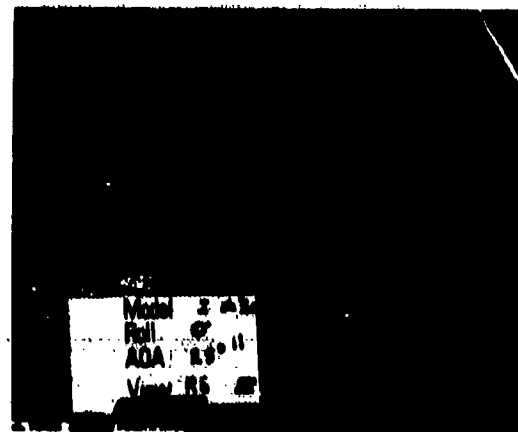
1a. PICTURE A- LEFT SIDE VIEW



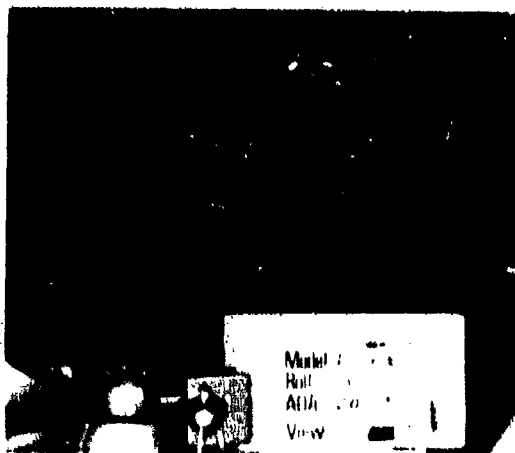
2a. PICTURE D- LEFT SIDE VIEW



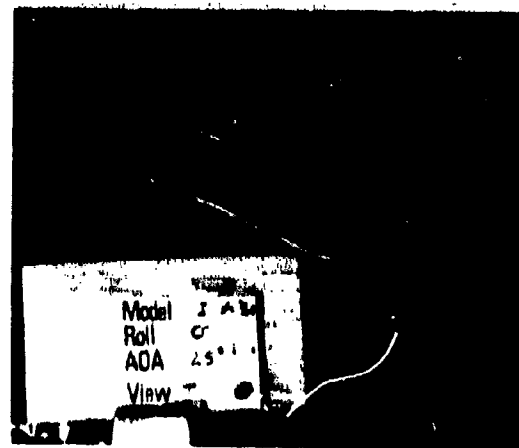
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

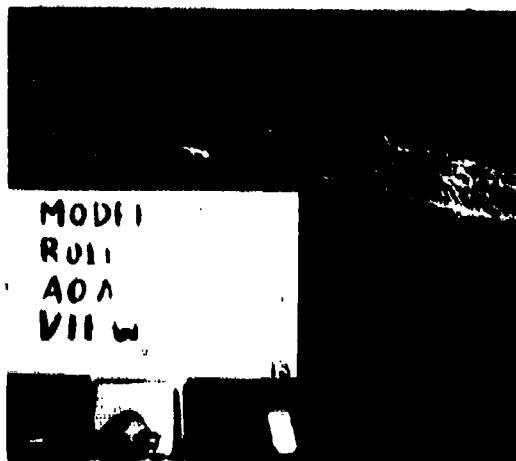


2c. PICTURE F- TOPSIDE VIEW

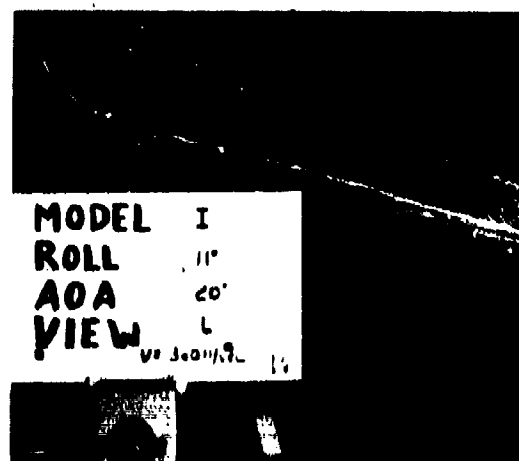
COLUMN 1. MISSILE 1, 0° ROLL, 20° AOA

COLUMN 2. MISSILE 1, 0° ROLL, 25° AOA

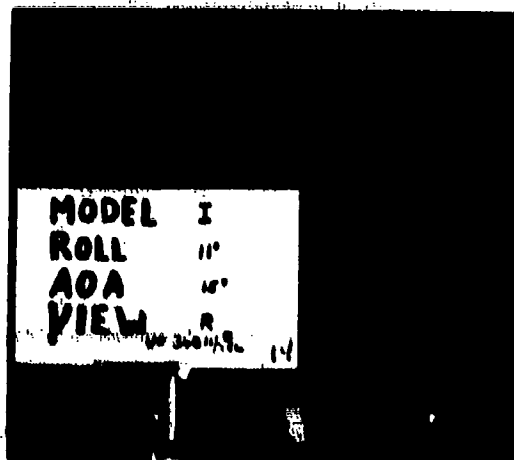
FIGURE E-2. OIL FLOW VISUALIZATION PHOTOGRAPHS



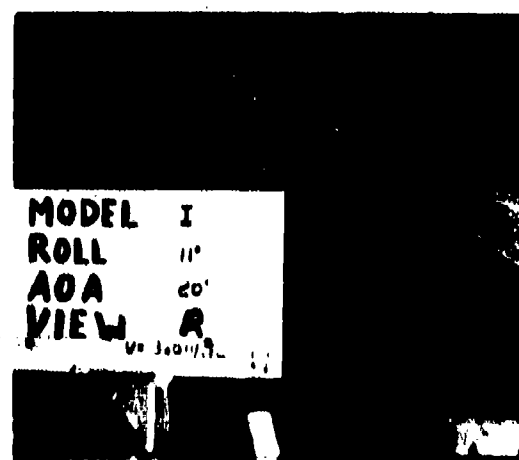
1a. PICTURE A- LEFT SIDE VIEW



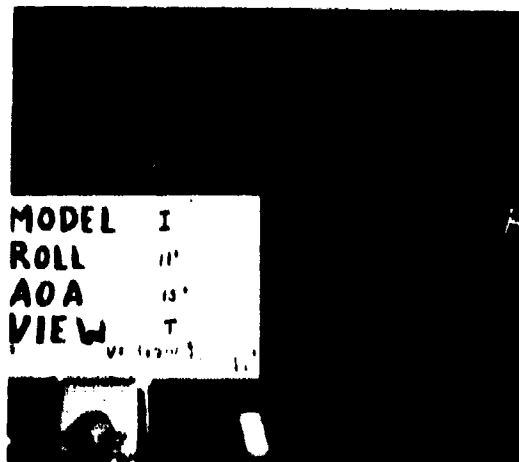
2a. PICTURE D- LEFT SIDE VIEW



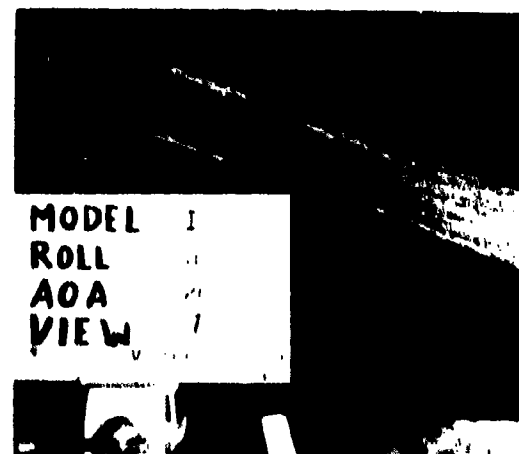
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW

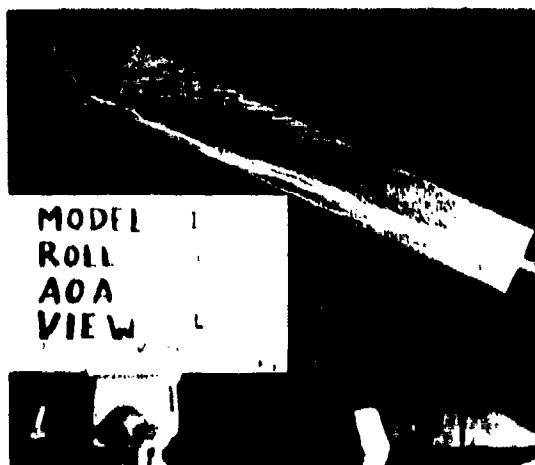


1c. PICTURE C- TOPSIDE VIEW  
COLUMN 1. MISSILE 1, 11° ROLL, 15° AOA

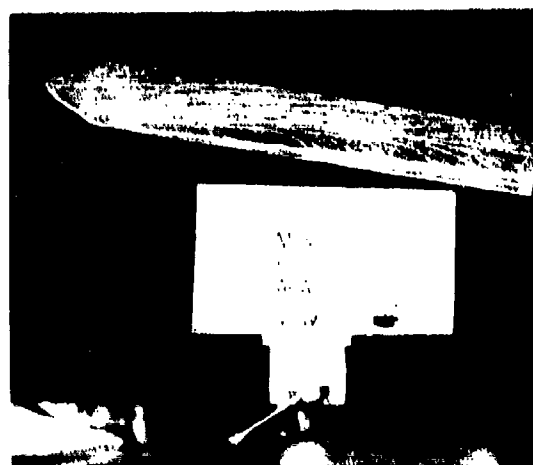


2c. PICTURE F- TOPSIDE VIEW  
COLUMN 2. MISSILE 1, 11° ROLL, 20° AOA

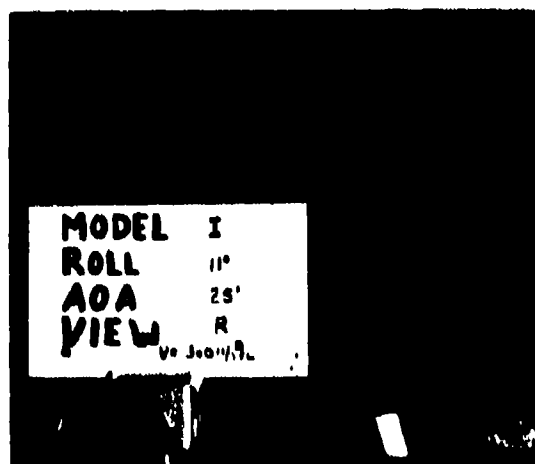
FIGURE E-3. OIL FLOW VISUALIZATION PHOTOGRAPHS



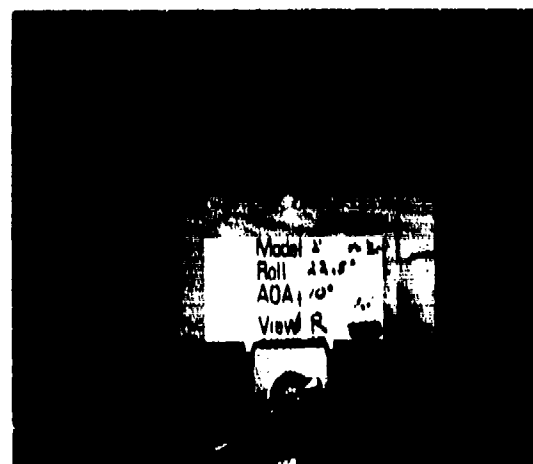
1a. PICTURE A- LEFT SIDE VIEW



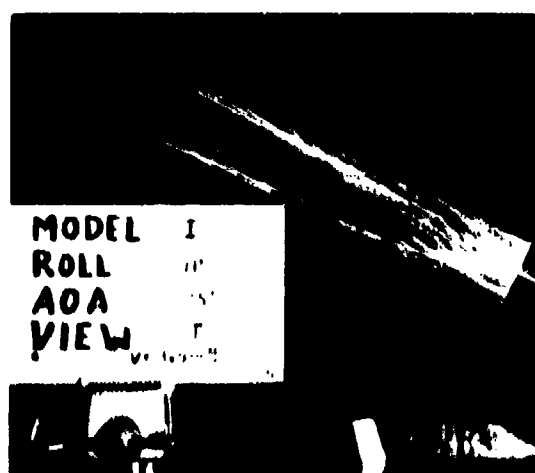
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

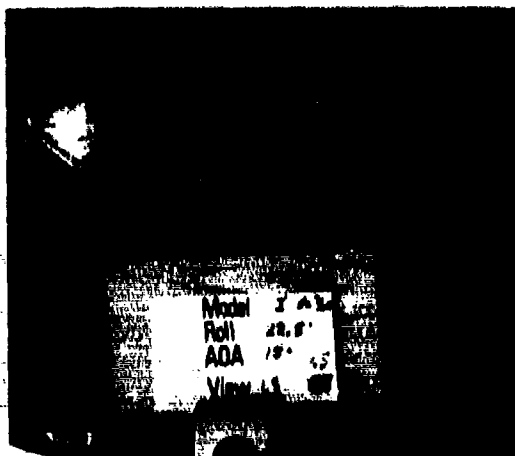
COLUMN 1, MISSILE 1, 11° ROLL, 25° AOA



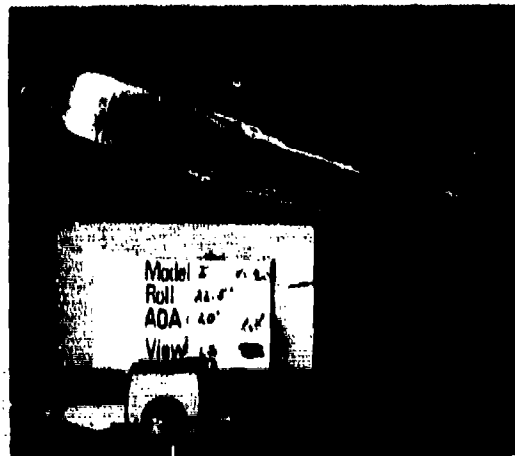
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2, MISSILE 1, 22.5° ROLL, 10° AOA

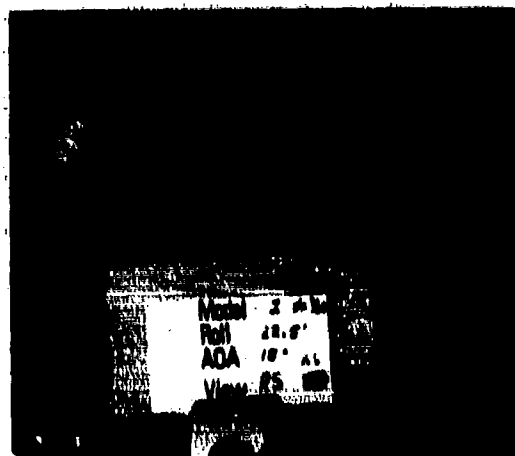
FIGURE E-4. OIL FLOW VISUALIZATION PHOTOGRAPHS



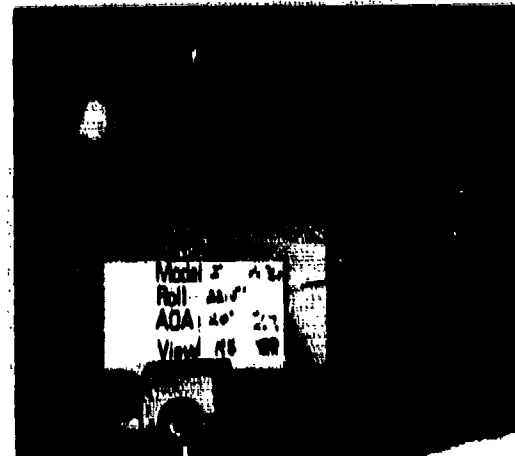
1a. PICTURE A- LEFT SIDE VIEW



2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

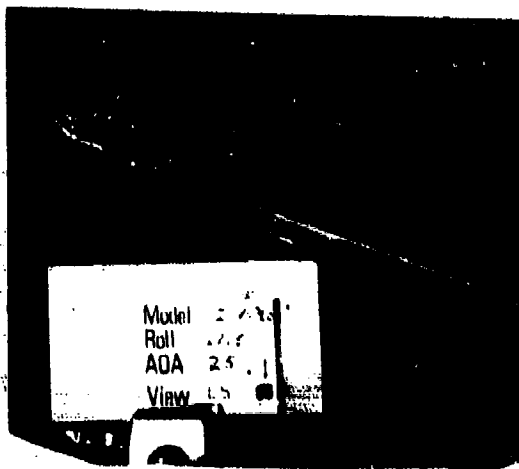


2b. PICTURE E- RIGHT SIDE VIEW

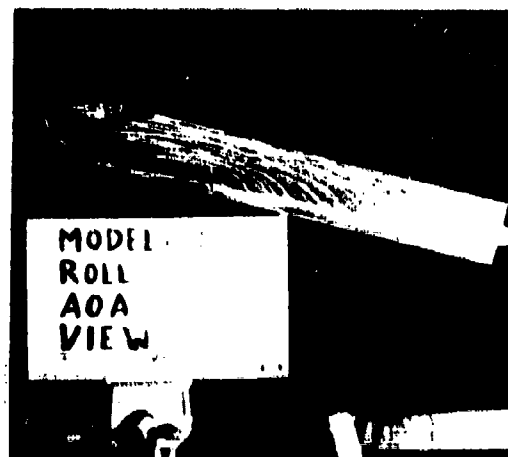
COLUMN 1. MISSILE 1, 22° ROLL, 15° AOA

COLUMN 2. MISSILE 1, 22° ROLL, 15° AOA

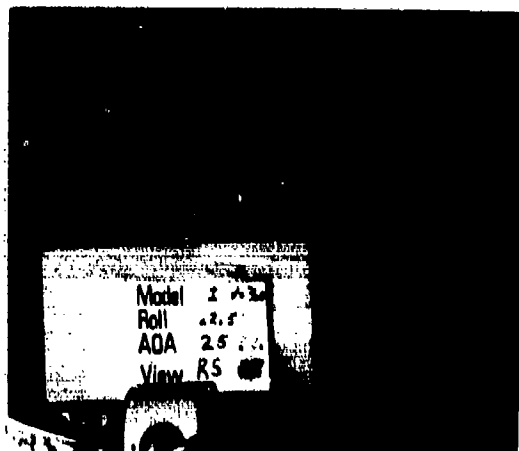
FIGURE E-5. OIL FLOW VISUALIZATION PHOTOGRAPHS



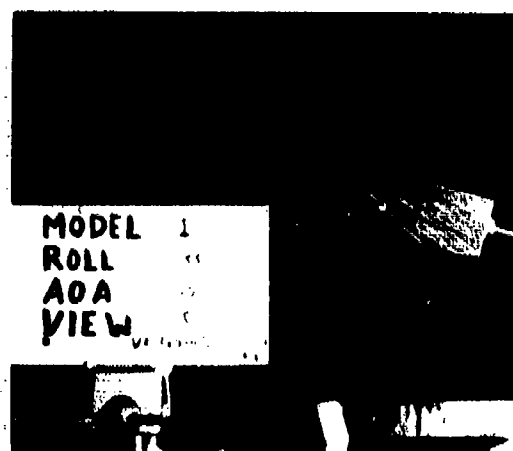
1a. PICTURE A- LEFT SIDE VIEW



2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

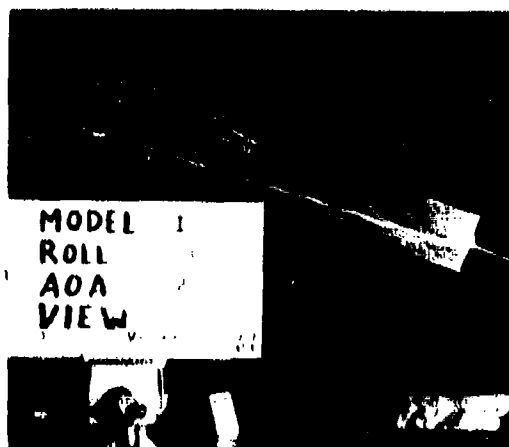
COLUMN 1. MISSILE 1, 22° ROLL, 25° AOA



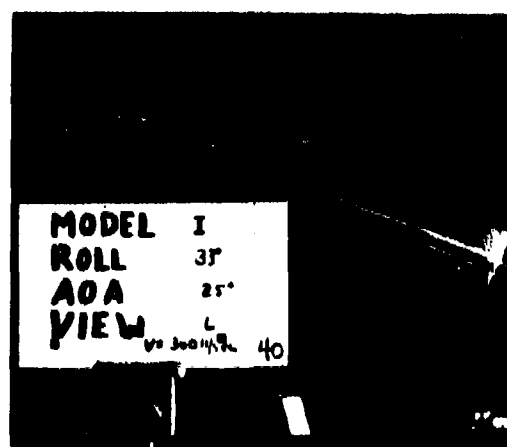
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE 1, 33° ROLL, 15° AOA

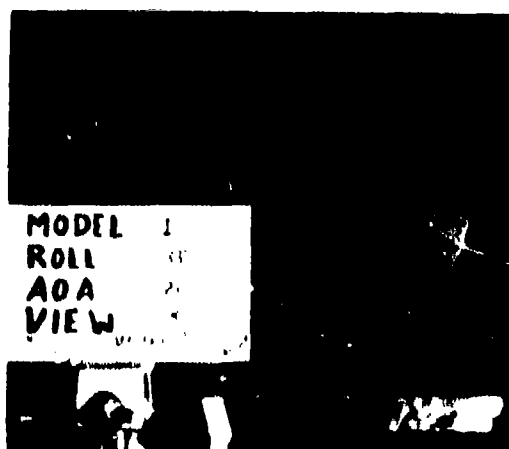
FIGURE E-6. OIL FLOW VISUALIZATION PHOTOGRAPHS



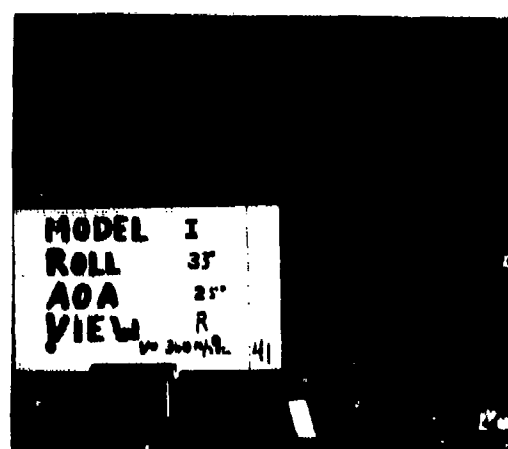
1a. PICTURE A- LEFT SIDE VIEW



2a. PICTURE D- LEFT SIDE VIEW



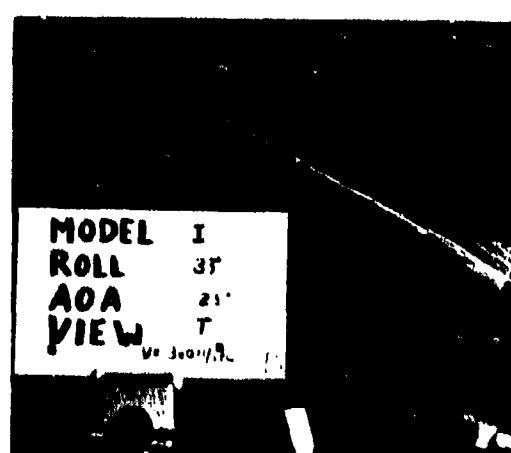
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW



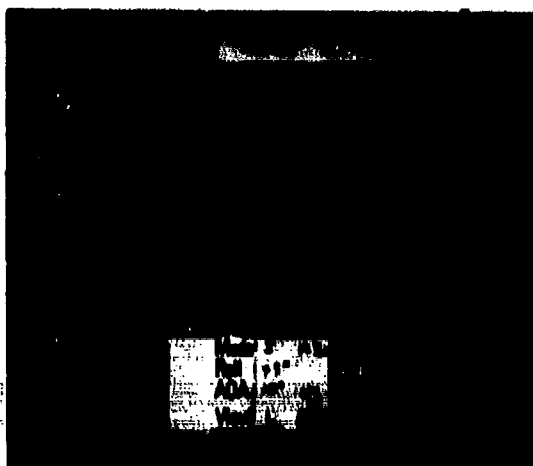
2c. PICTURE F- TOPSIDE VIEW

COLUMN 1. MISSILE 1, 35° ROLL, 25° AOA

COLUMN 2. MISSILE 1, 35° ROLL, 25° AOA

FIGURE E-7 OIL FLOW VISUALIZATION PHOTOGRAPHS

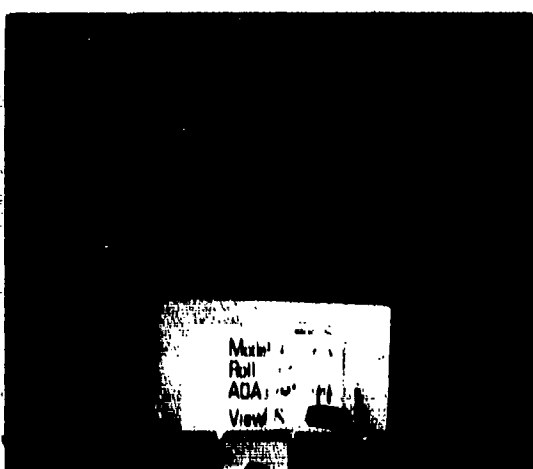




1a. PICTURE A- LEFT SIDE VIEW



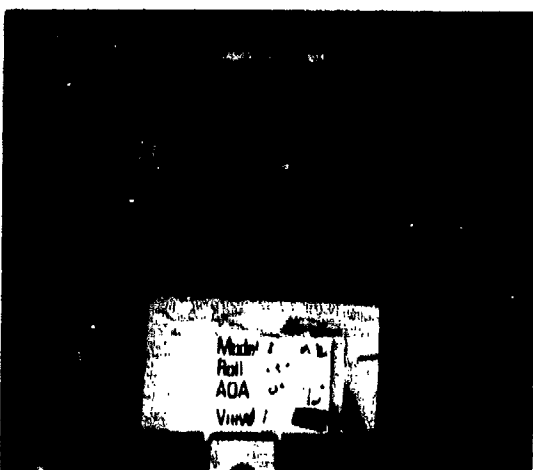
2a. PICTURE D- LEFT SIDE VIEW



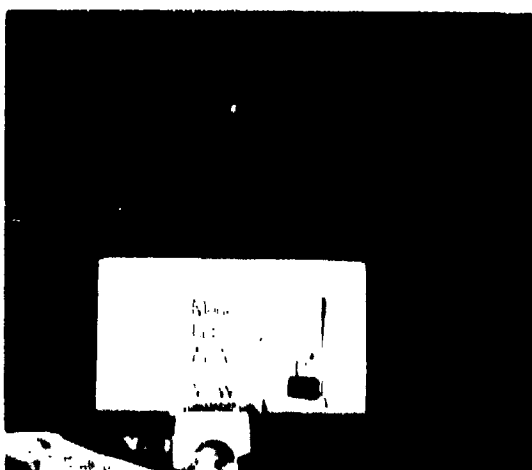
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

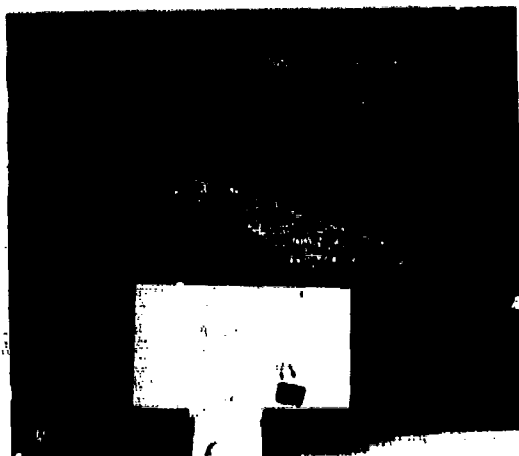


2c. PICTURE F- TOPSIDE VIEW

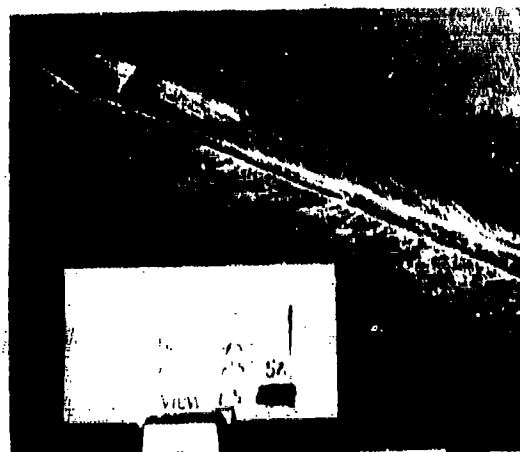
COLUMN 1. MISSILE 1, 45° ROLL, 10° AOA

COLUMN 2. MISSILE 1, 45° ROLL, 15° AOA

FIGURE E-8. OIL FLOW VISUALIZATION PHOTOGRAPHS



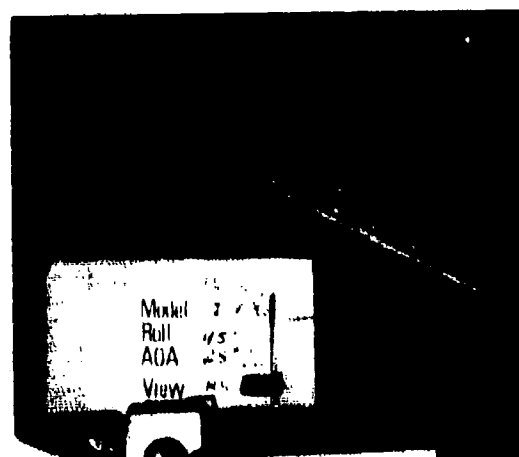
1a. PICTURE A- LEFT SIDE VIEW



2a. PICTURE D- LEFT SIDE VIEW



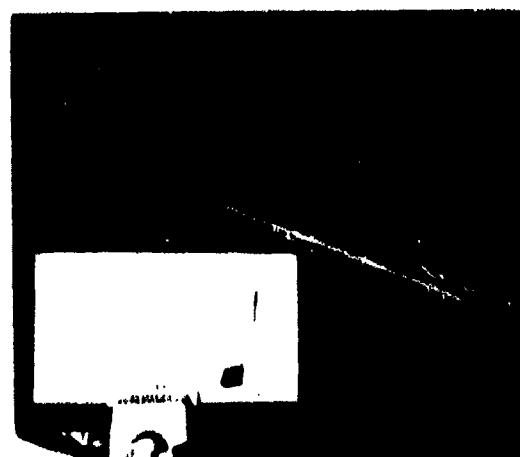
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW

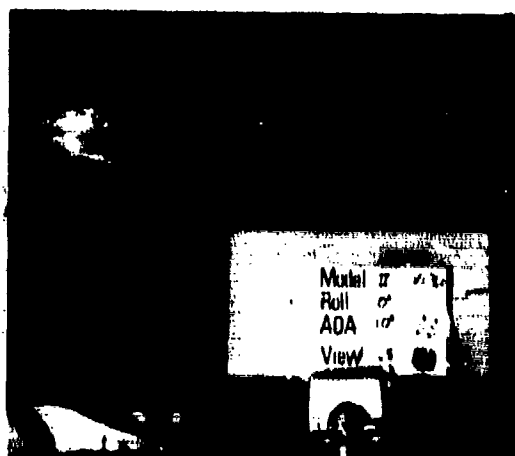


1c. PICTURE C- TOPSIDE VIEW  
COLUMN 1. MISSILE 1, 45° ROLL, 30° AOA

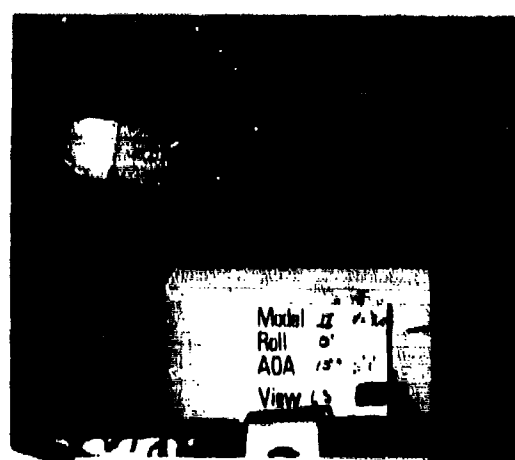


2c. PICTURE F- TOPSIDE VIEW  
COLUMN 2. MISSILE 1, 45° ROLL, 30° AOA

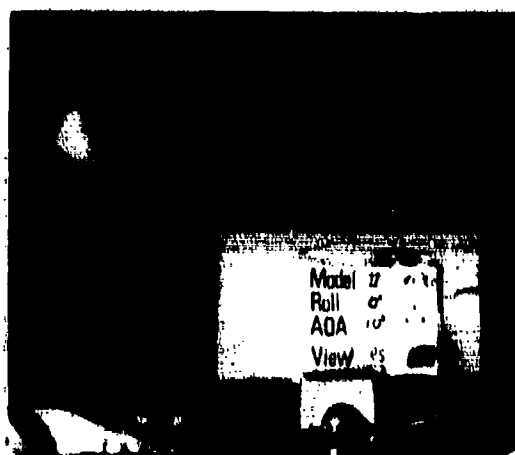
# FIGURE E-9 OIL FLOW VISUALIZATION PHOTOGRAPHS



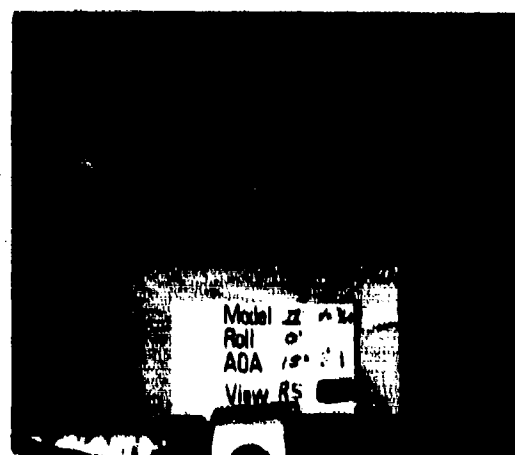
1a. PICTURE A- LEFT SIDE VIEW



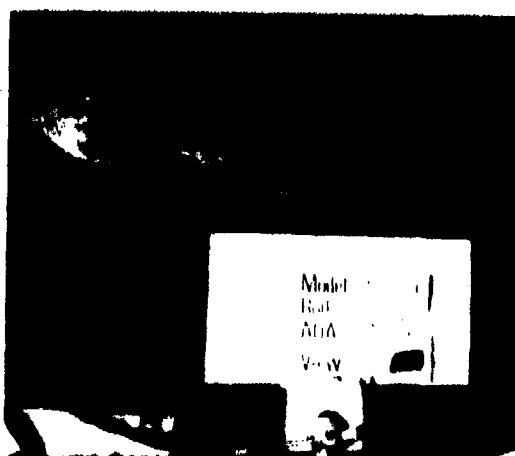
2a. PICTURE D- LEFT SIDE VIEW



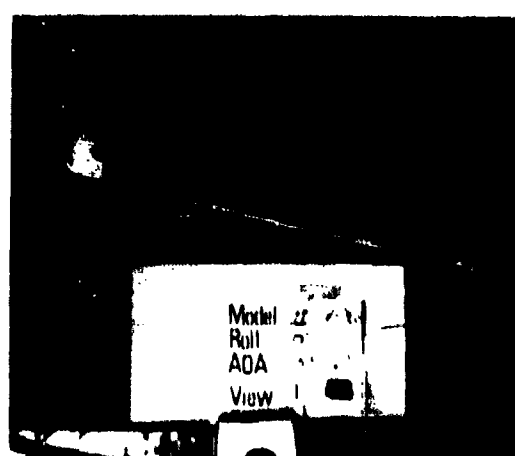
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW

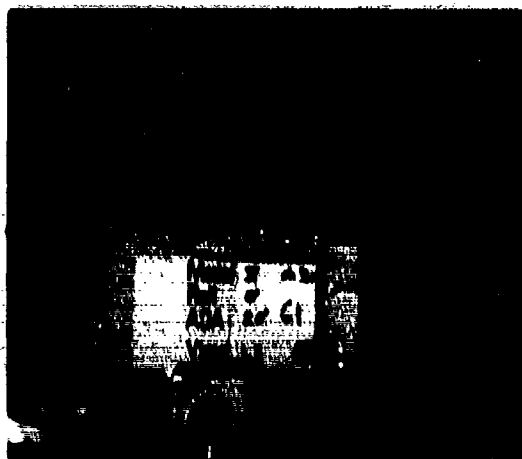


1c. PICTURE C- TOPSIDE VIEW  
COLUMN 1. MISSILE 11, 0° ROLL, 10° ADA

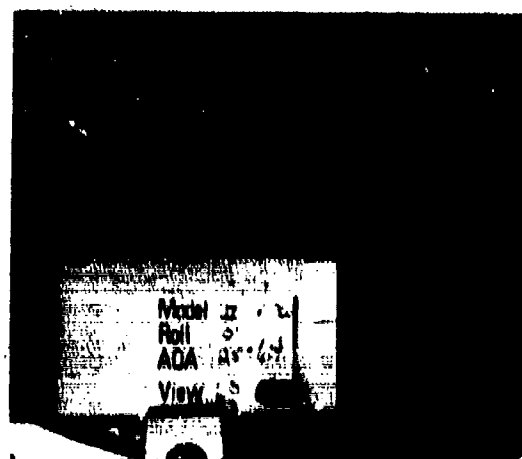


2c. PICTURE F- TOPSIDE VIEW  
COLUMN 2. MISSILE 11, 0° ROLL, 15° ADA

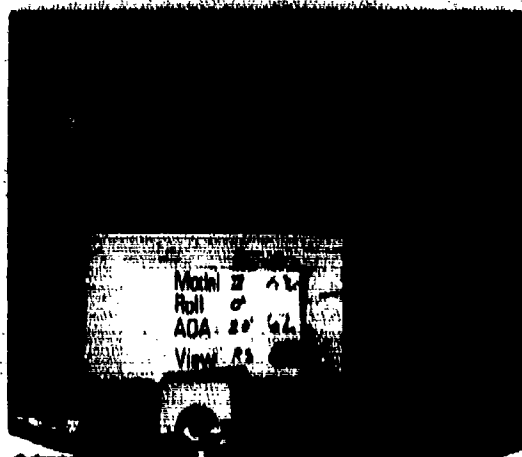
# FIGURE E-10. OIL FLOW VISUALIZATION PHOTOGRAPHS



1a. PICTURE A- LEFT SIDE VIEW



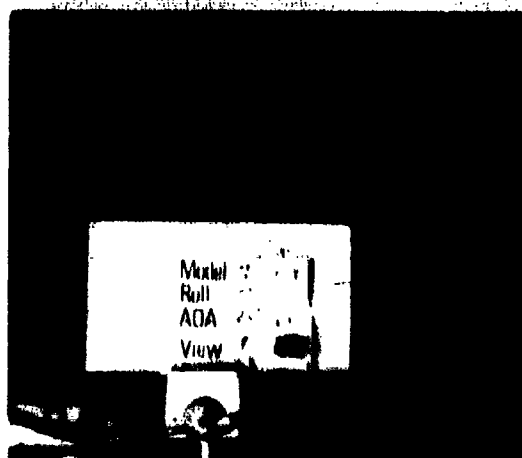
2a. PICTURE D- LEFT SIDE VIEW



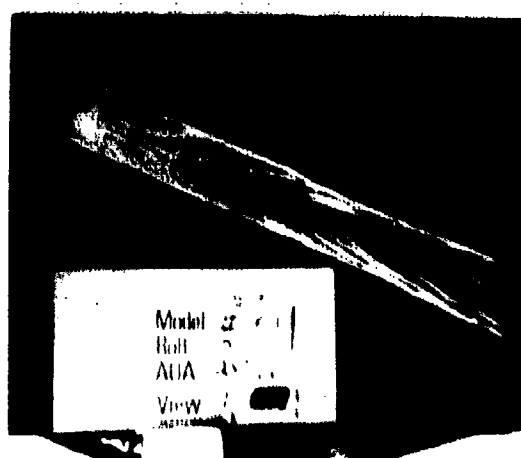
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

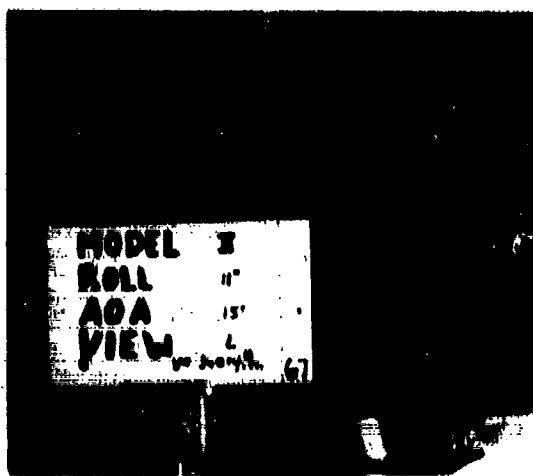


2c. PICTURE F- TOPSIDE VIEW

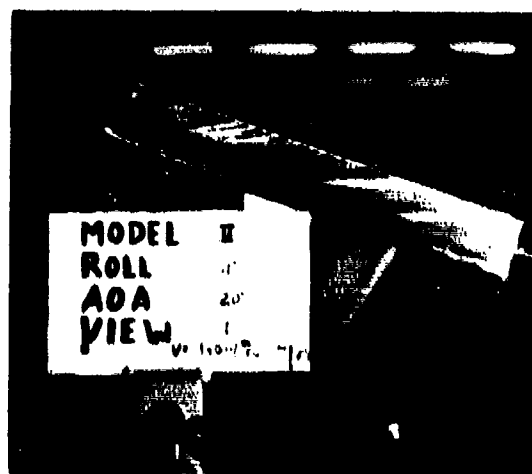
COLUMN 1. MISSILE 11, 0° ROLL, 20° AOA

COLUMN 2. MISSILE 11, 0° ROLL, 25° AOA

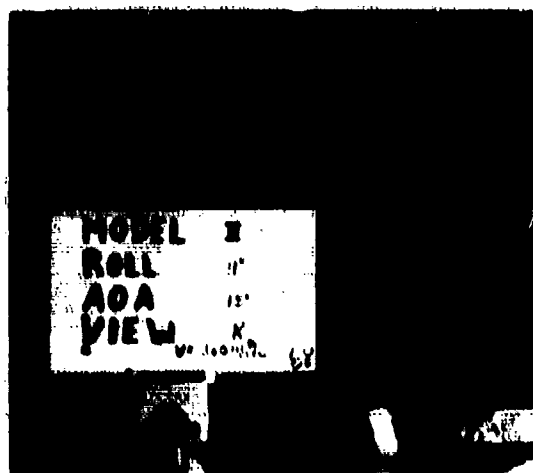
FIGURE E-11. OIL FLOW VISUALIZATION PHOTOGRAPHS



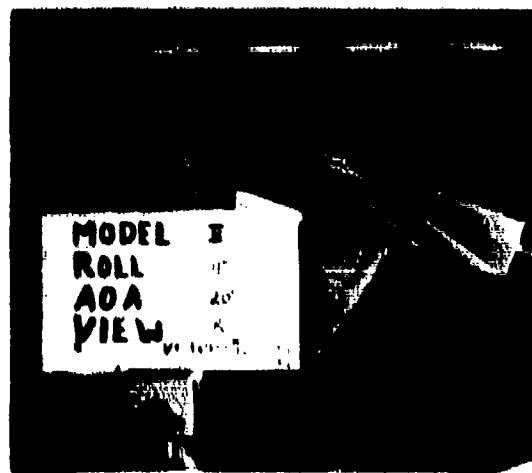
1a. PICTURE A- LEFT SIDE VIEW



2a. PICTURE D- LEFT SIDE VIEW



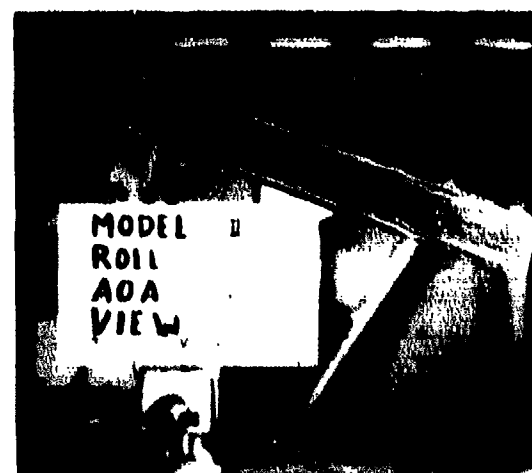
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

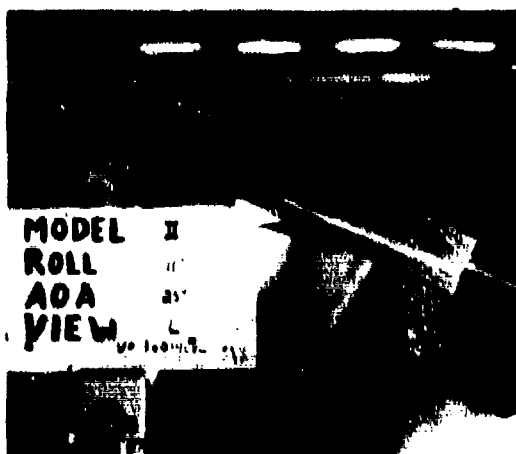


2c. PICTURE F- TOPSIDE VIEW

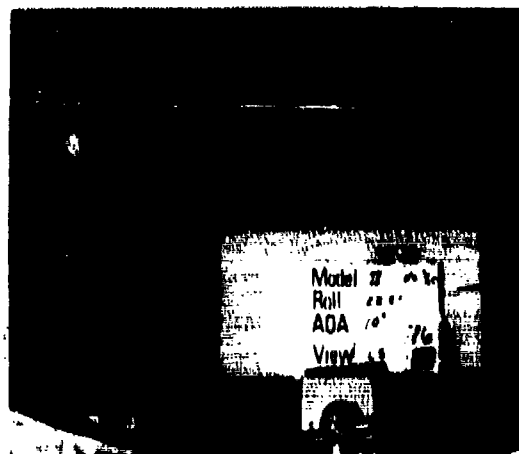
COLUMN 1. MISSILE II, 11° ROLL, 15° AOA

COLUMN 2. MISSILE II, 11° ROLL, 20° AOA

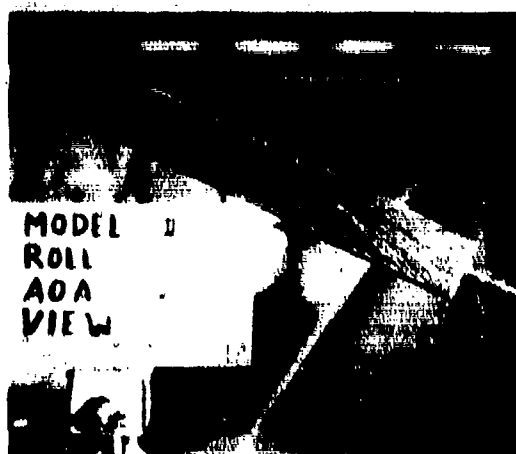
FIGURE E-12. OIL FLOW VISUALIZATION PHOTOGRAPHS



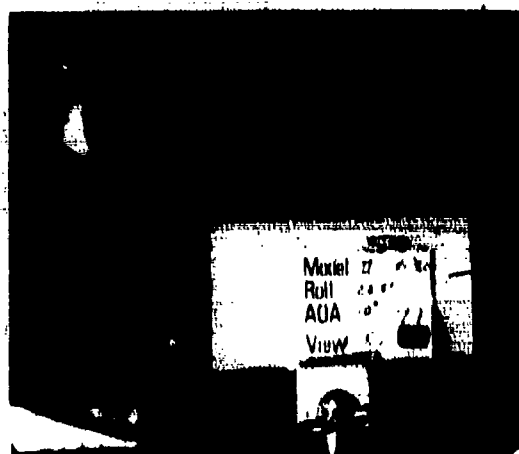
1a. PICTURE A- LEFT SIDE VIEW



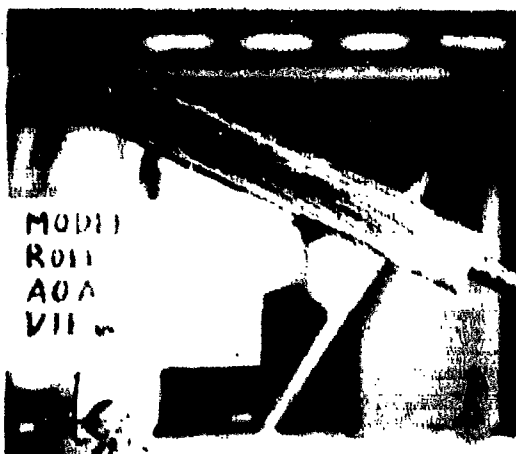
2a. PICTURE D- LEFT SIDE VIEW



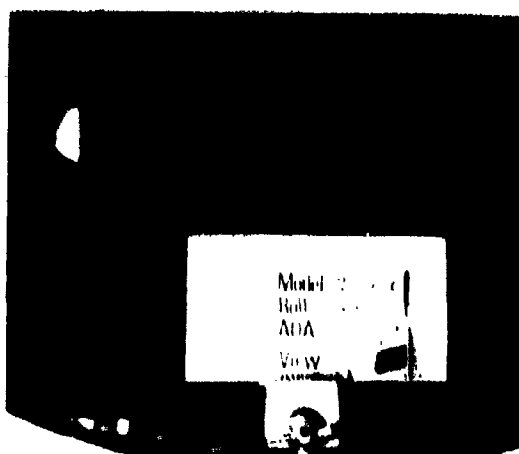
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

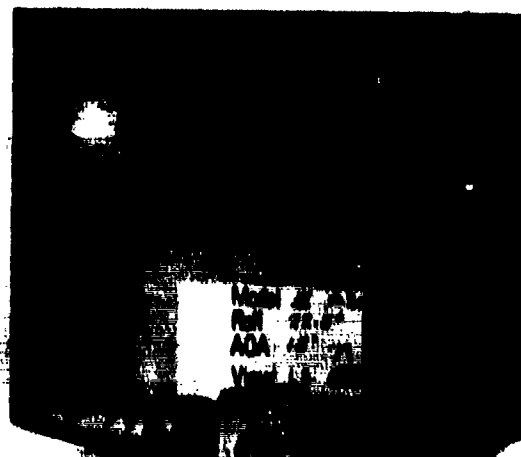


2c. PICTURE F- TOPSIDE VIEW

COLUMN 1. MISSILE II, 11° ROLL, 25° AOA

COLUMN 2. MISSILE II, 22° ROLL, 10° AOA

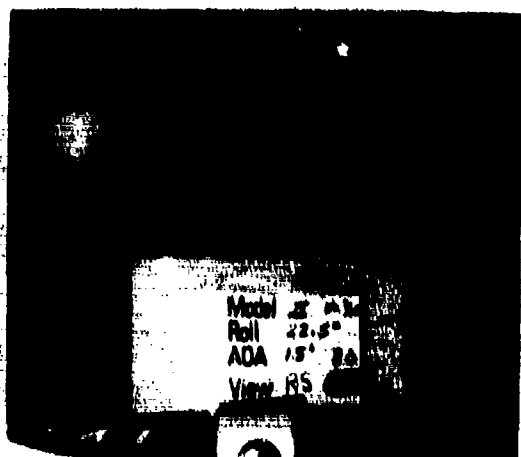
FIGURE E-13 OIL FLOW VISUALIZATION PHOTOGRAPHS



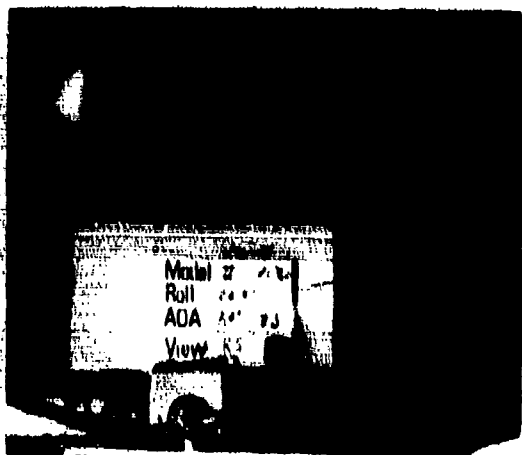
1a. PICTURE A- LEFT SIDE VIEW



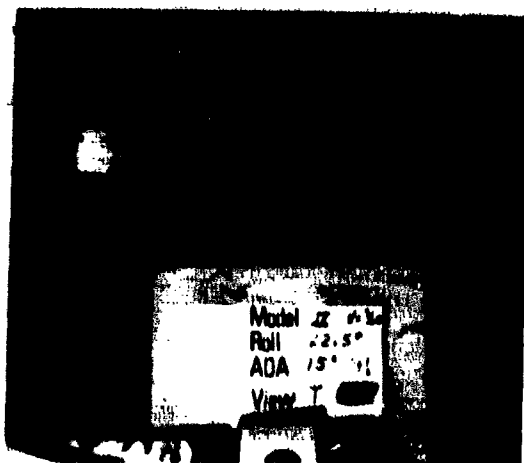
2a. PICTURE D- LEFT SIDE VIEW



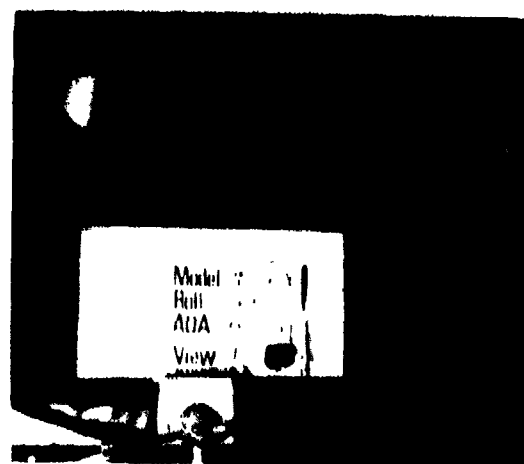
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

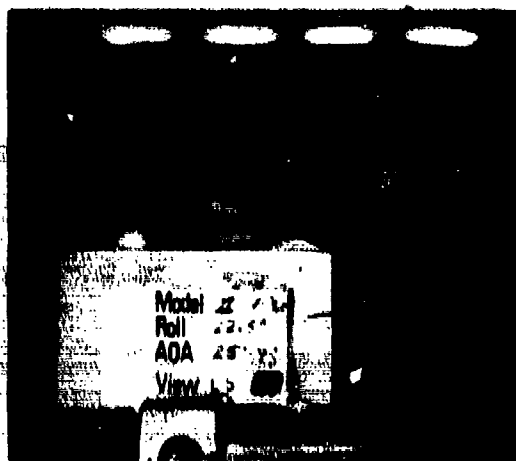


2c. PICTURE F- TOPSIDE VIEW

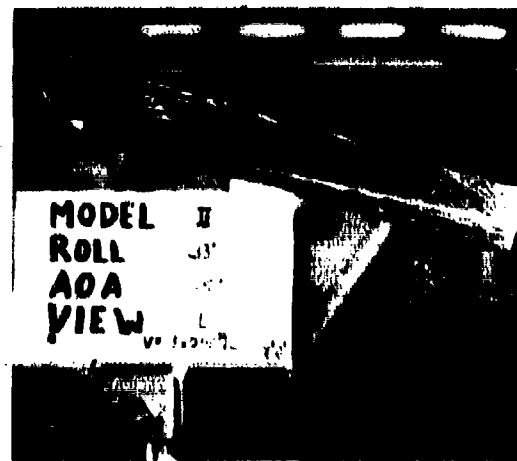
COLUMN 1. MISSILE 11, 22° ROLL, 15° AOA

COLUMN 2. MISSILE 11, 22° ROLL, 20° AOA

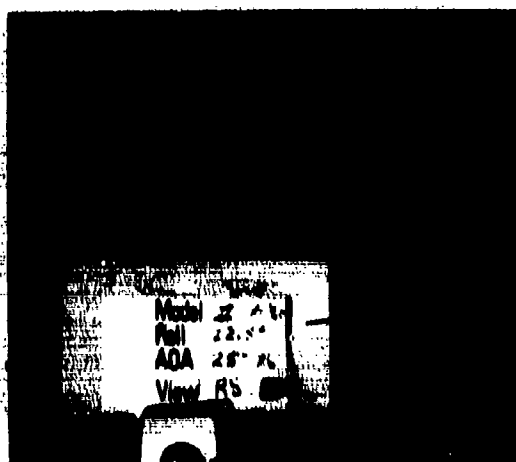
FIGURE E-14. OIL FLOW VISUALIZATION PHOTOGRAPHS



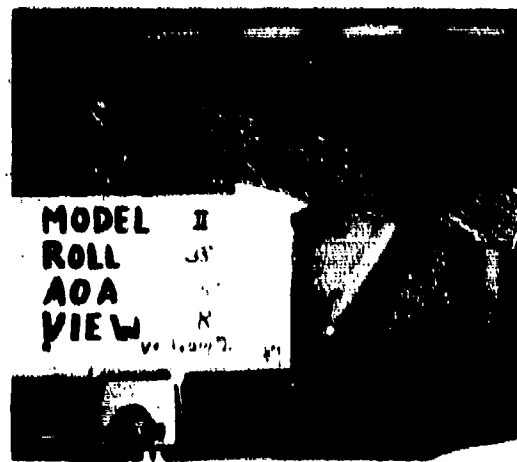
1a. PICTURE A- LEFT SIDE VIEW



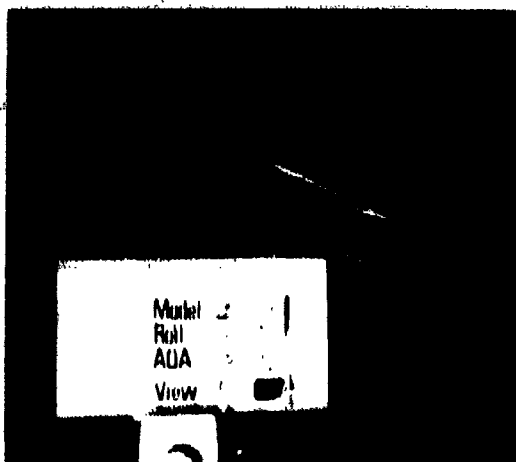
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW



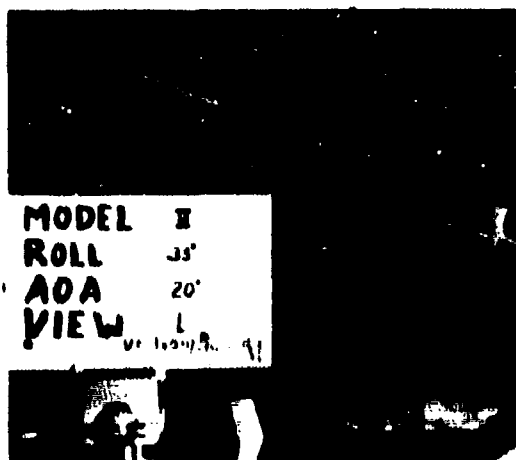
2c. PICTURE F- TOPSIDE VIEW

(COLUMN 1. MISSILE 11, 22° ROLL, 25° AOA)

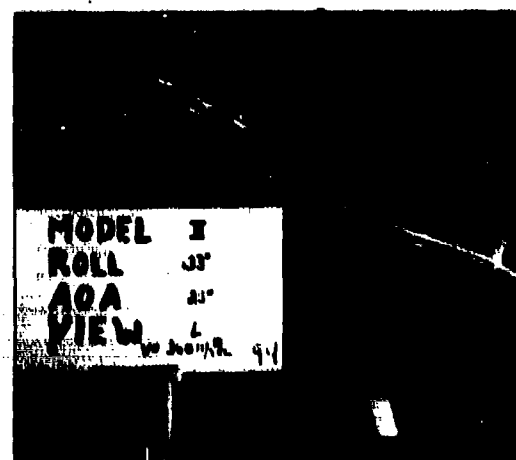
(COLUMN 2. MISSILE 11, 33° ROLL, 25° AOA)

FIGURE E-15. OIL FLOW VISUALIZATION PHOTOGRAPHS

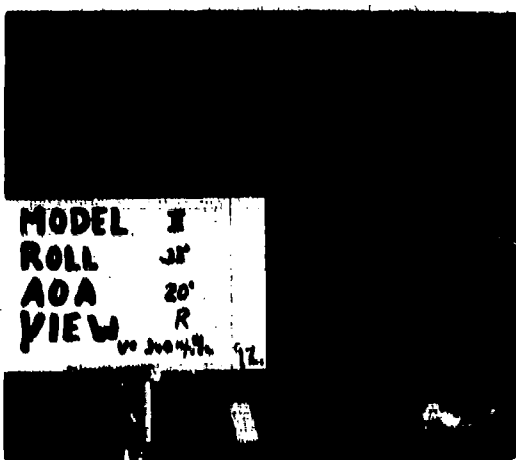




1a. PICTURE A- LEFT SIDE VIEW



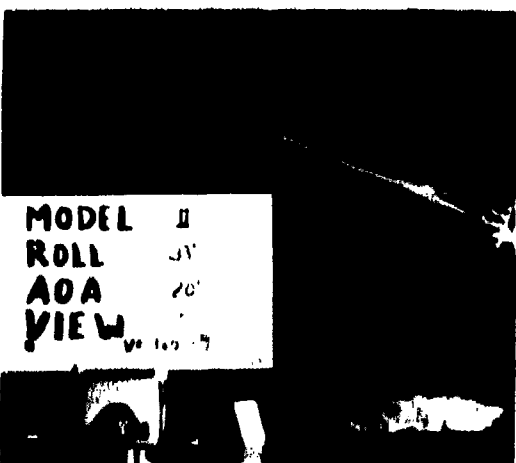
2a. PICTURE D- LEFT SIDE VIEW



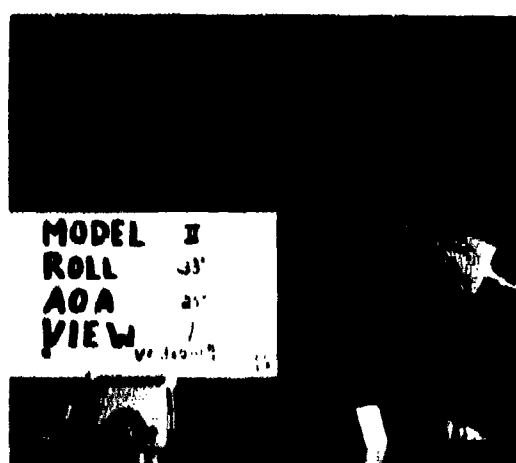
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

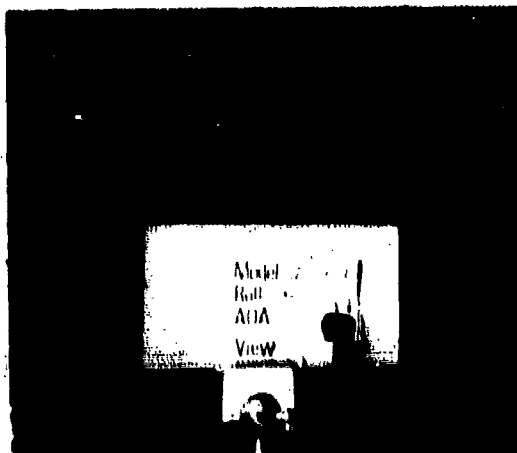


2c. PICTURE F- TOPSIDE VIEW

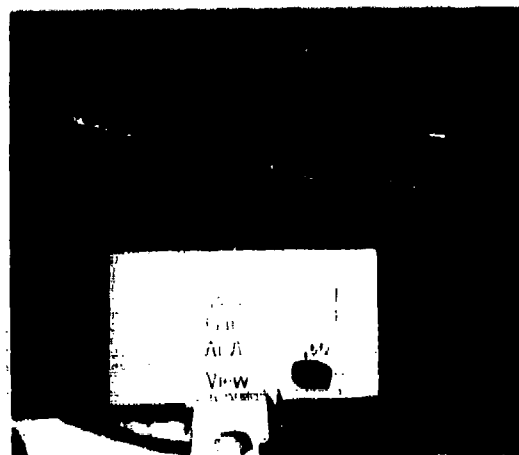
COLUMN 1. MISSILE II, 33° ROLL, 20° AOA

COLUMN 2. MISSILE I, 33° ROLL, 25° AOA

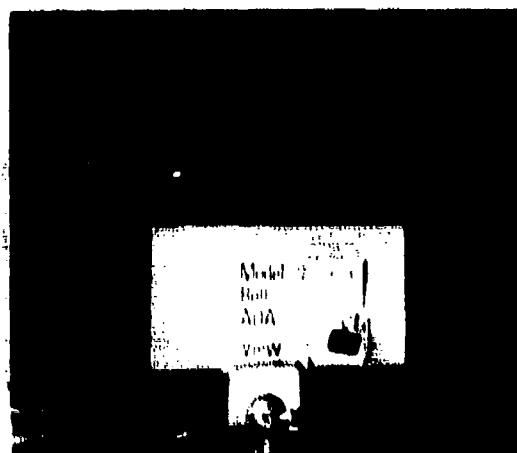
FIGURE E-16. OIL FLOW VISUALIZATION PHOTOGRAPHS



1a. PICTURE A- LEFT SIDE VIEW



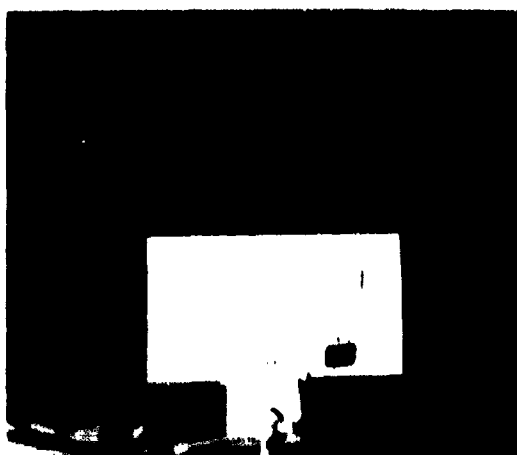
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

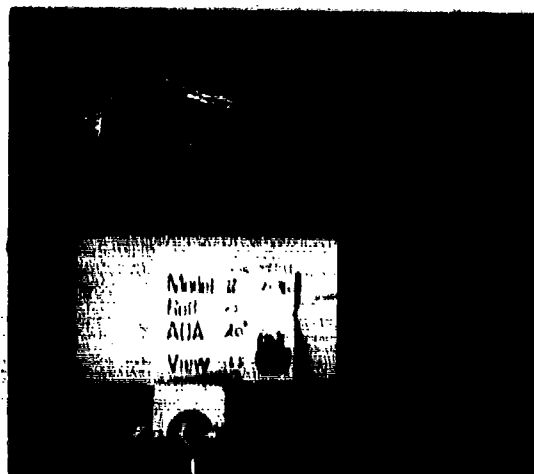
COLUMN 1. MISSILE 11, 15° ROLL, 10° AOA



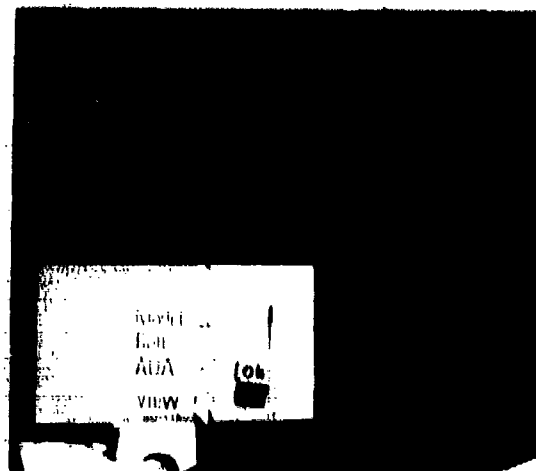
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE 11, 15° ROLL, 10° AOA

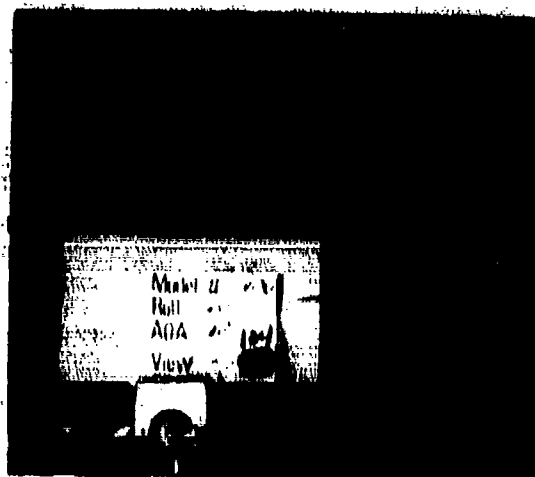
FIGURE E-17. OIL FLOW VISUALIZATION PHOTOGRAPHS



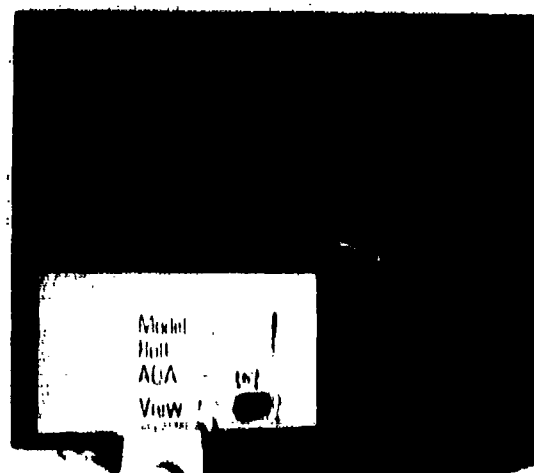
1a. PICTURE A- LEFT SIDE VIEW



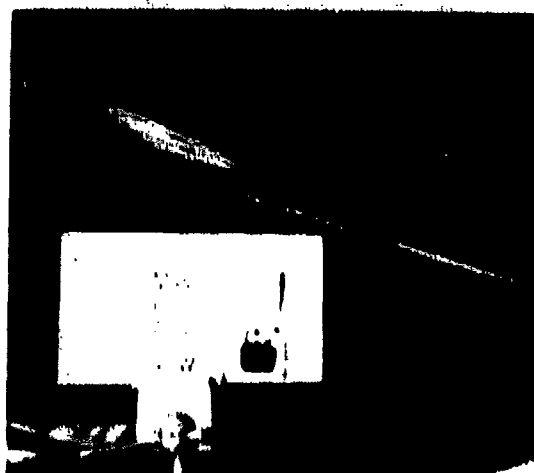
2a. PICTURE D- LEFT SIDE VIEW



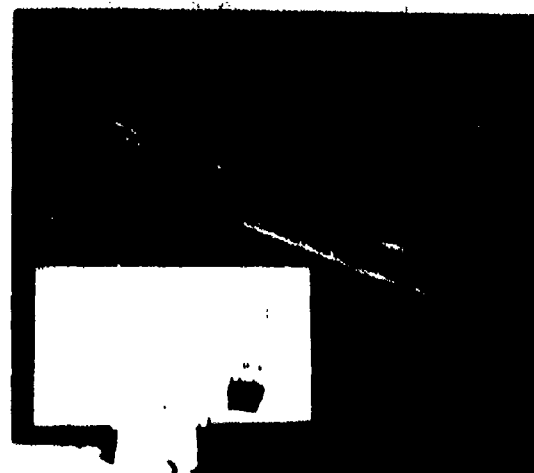
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

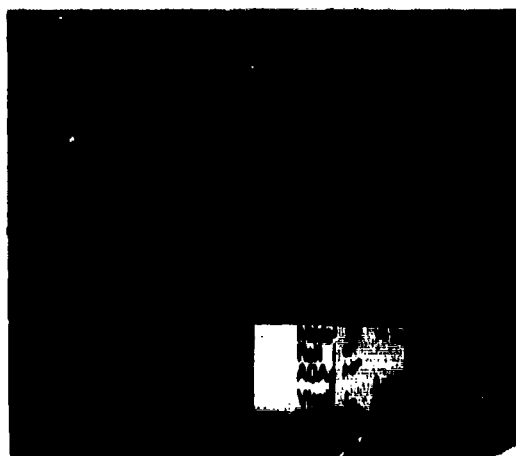


2c. PICTURE F- TOPSIDE VIEW

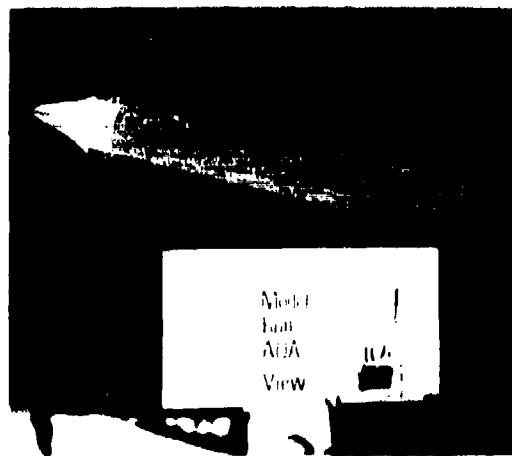
COLUMN 1. MISSILE 11, 45° ROLL, 20° AOA

COLUMN 2. MISSILE 11, 45° ROLL, 25° AOA

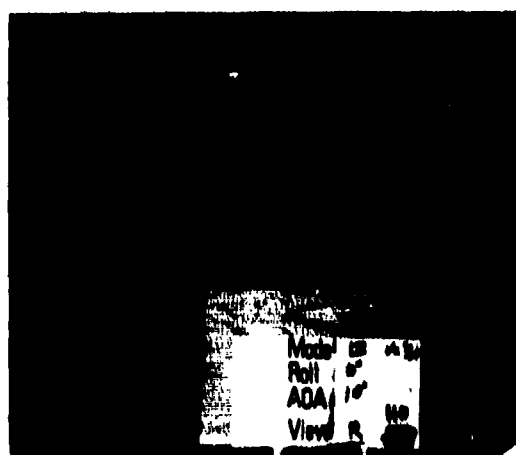
# FIGURE E-18 OIL FLOW VISUALIZATION PHOTOGRAPHS



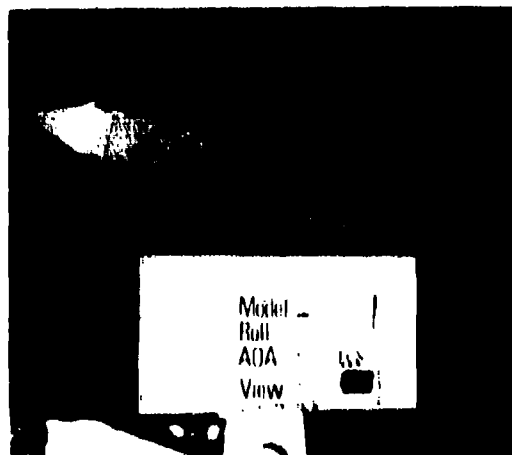
1a. PICTURE A- LEFT SIDE VIEW



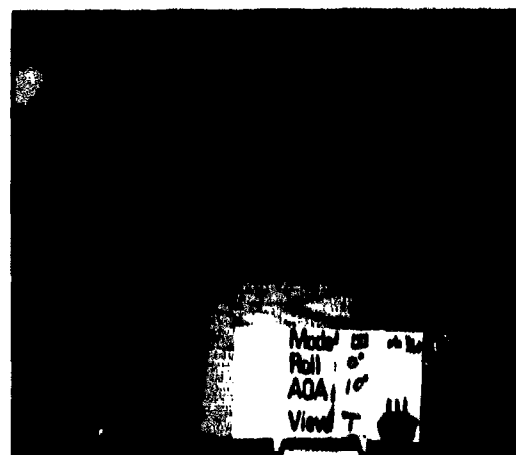
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

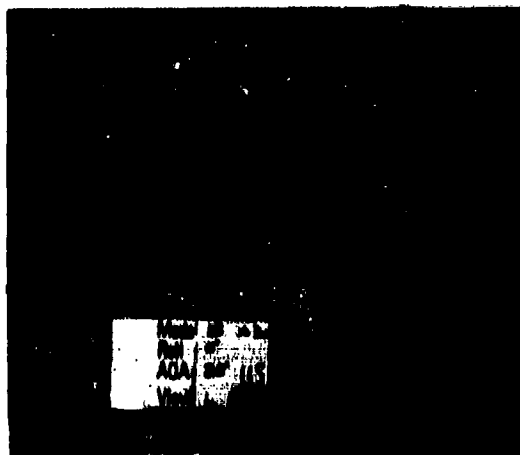
COLUMN 1. MISSILE 111, 0° ROLL, 10° AOA



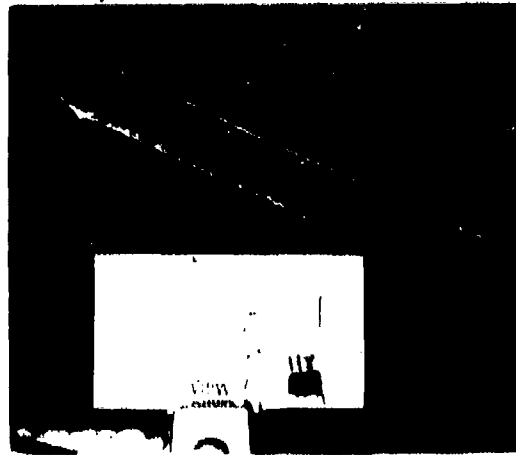
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE 111, 0° ROLL, 15° AOA

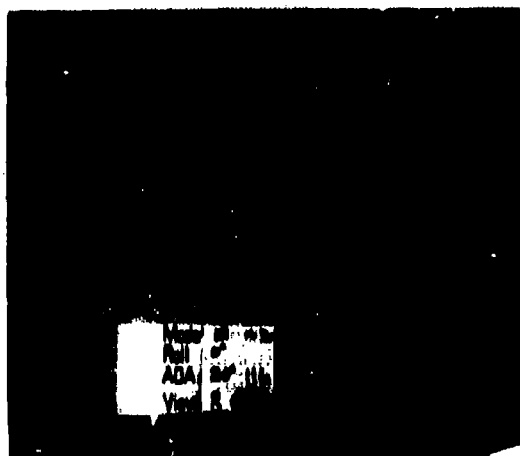
FIGURE E-19. OIL FLOW VISUALIZATION PHOTOGRAPHS



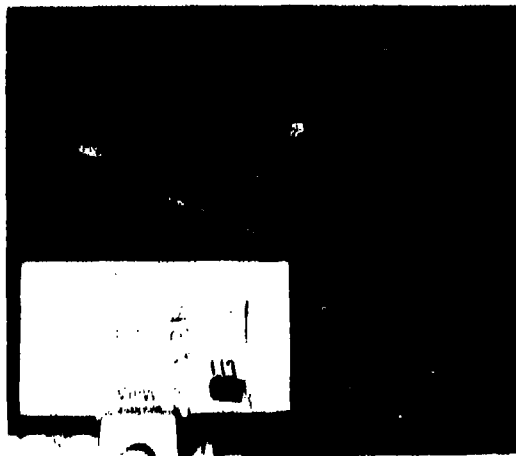
1a. PICTURE A- LEFT SIDE VIEW



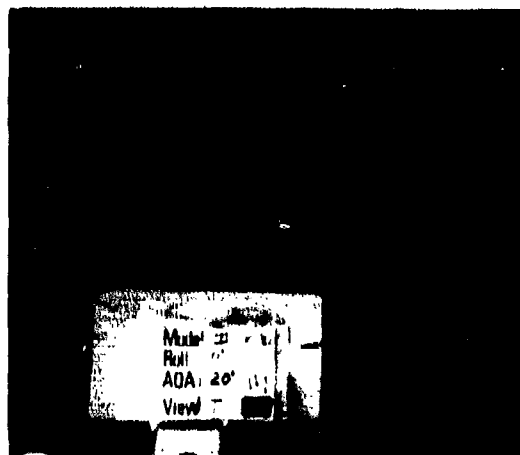
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

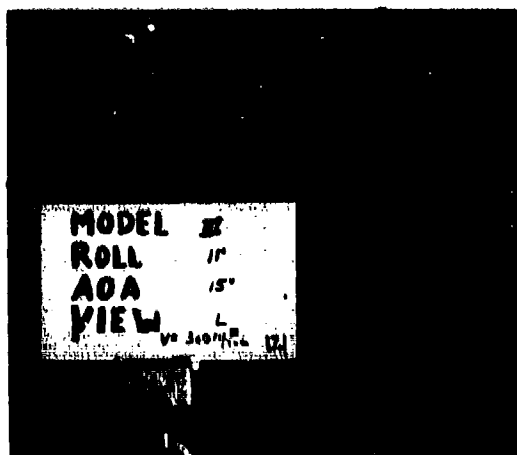
COLUMN 1. MISSILE 111, 0° ROLL, 20° AOA



2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE 111, 0° ROLL, 25° AOA

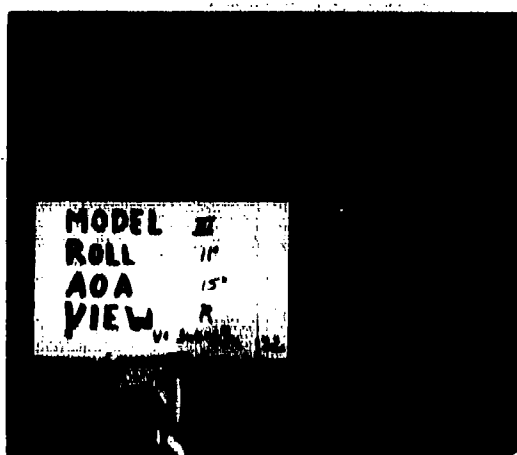
# FIGURE E-20 OIL FLOW VISUALIZATION PHOTOGRAPHS



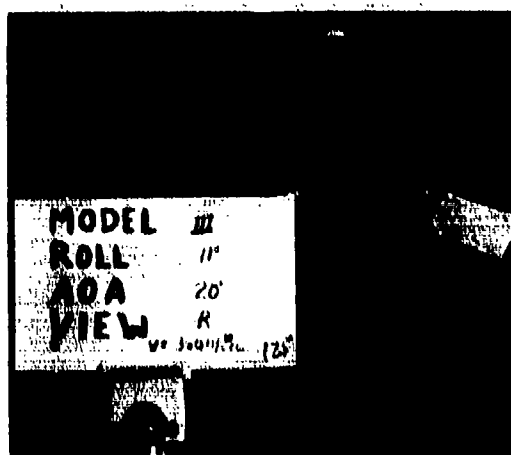
1a. PICTURE A- LEFT SIDE VIEW



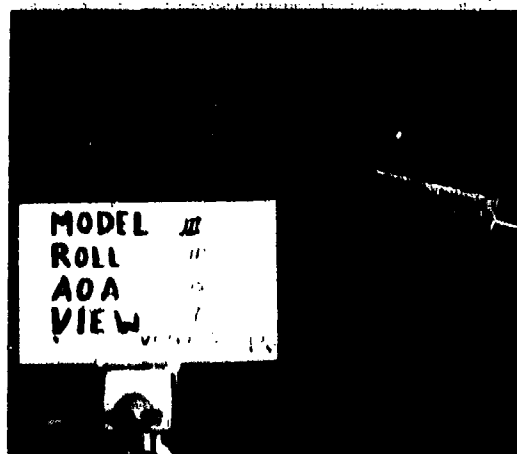
2a. PICTURE D- LEFT SIDE VIEW



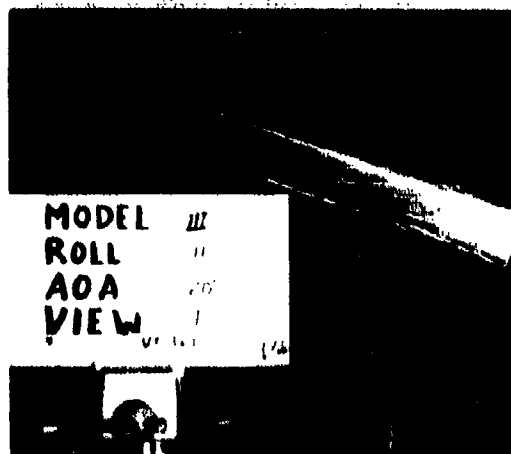
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

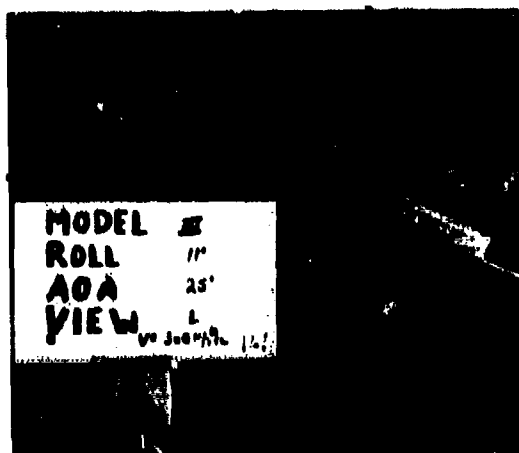


2c. PICTURE F- TOPSIDE VIEW

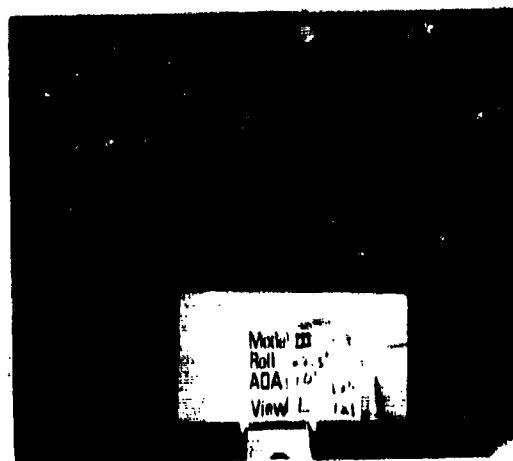
COLUMN 1. MISSILE III, 11° ROLL, 15° AOA

COLUMN 2. MISSILE III, 11° ROLL, 20° AOA

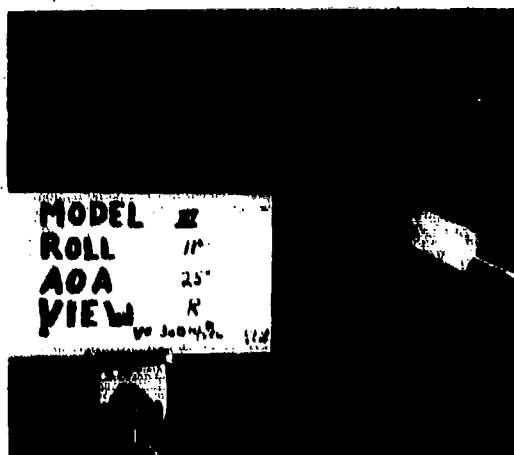
FIGURE E-21 OIL FLOW VISUALIZATION PHOTOGRAPHS



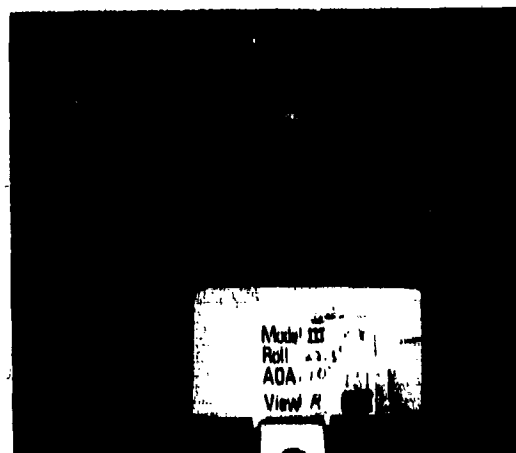
1a. PICTURE A- LEFT SIDE VIEW



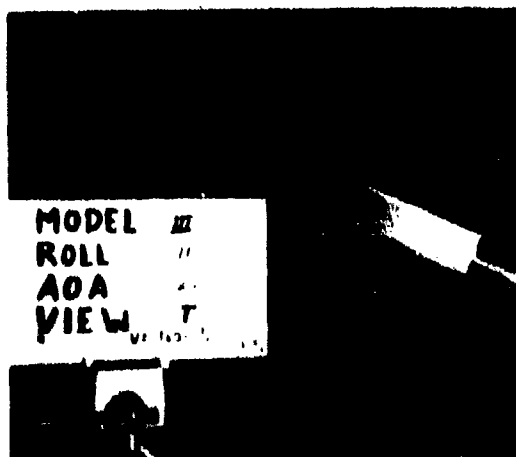
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

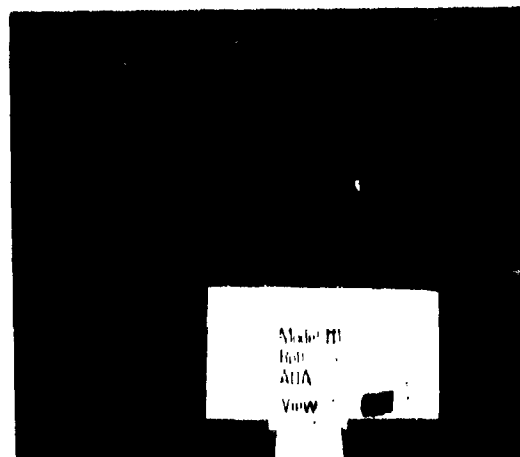


2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

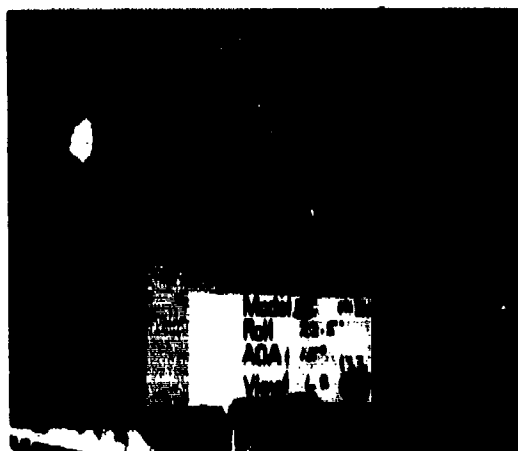
COLUMN 1. MISSILE III, 11° ROLL, 25° AOA



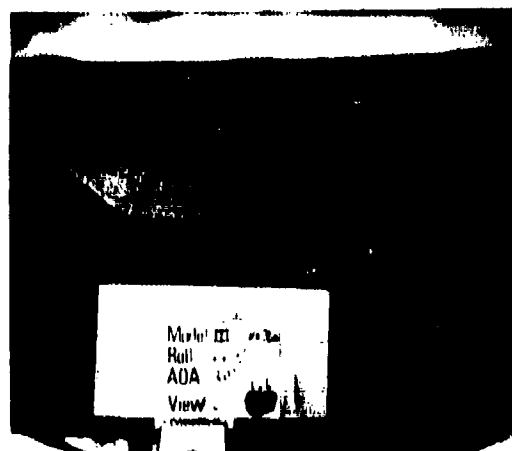
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE III, 11° ROLL, 10° AOA

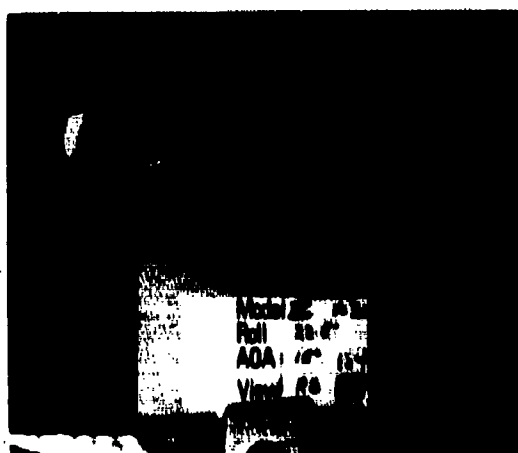
FIGURE E-22. OIL FLOW VISUALIZATION PHOTOGRAPHS



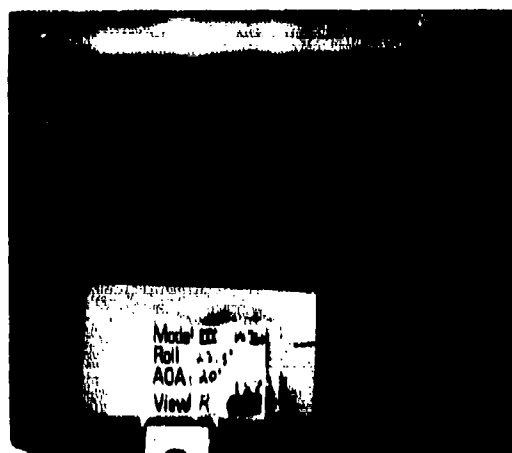
1a. PICTURE A- LEFT SIDE VIEW



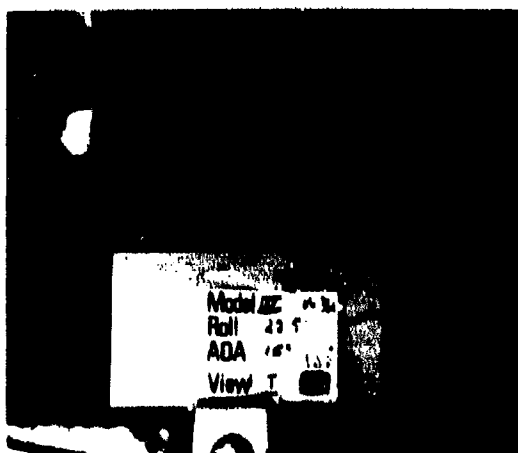
2a. PICTURE D- LEFT SIDE VIEW



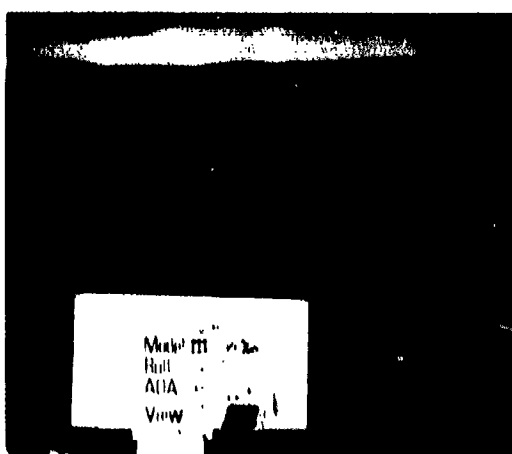
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW



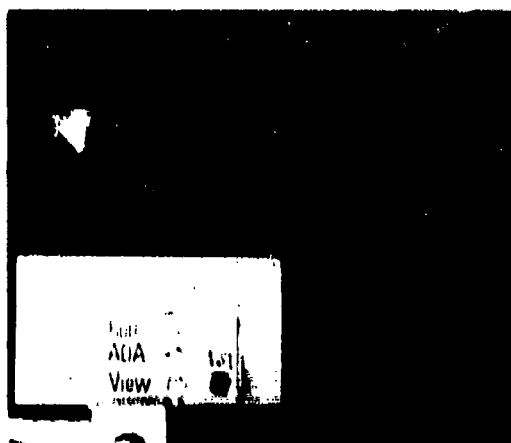
2c. PICTURE F- TOPSIDE VIEW

COLUMN 1. MODEL M, 25.5° ROLL, 15° AOA

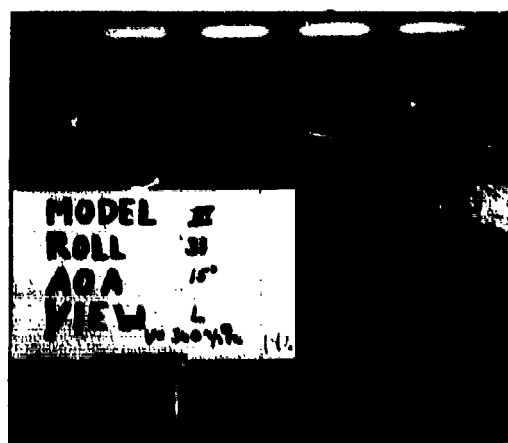
COLUMN 2. MODEL M, 25.5° ROLL, 15° AOA

FIGURE E-23. OIL FLOW VISUALIZATION PHOTOGRAPHS

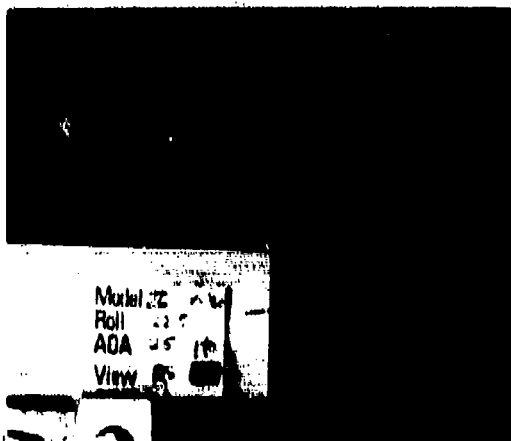




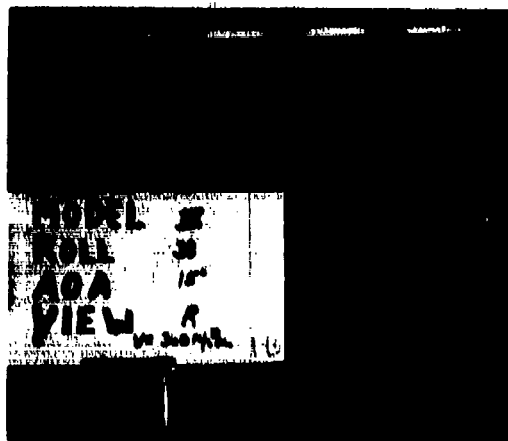
1a. PICTURE A- LEFT SIDE VIEW



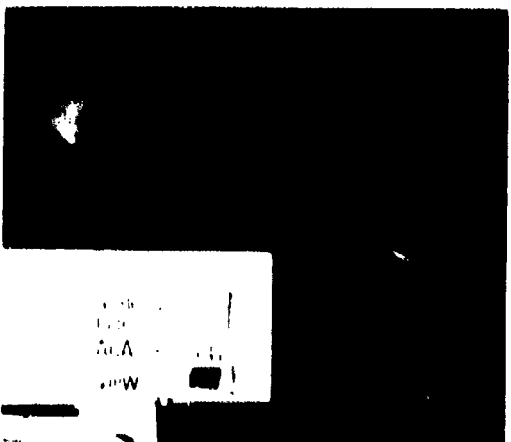
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

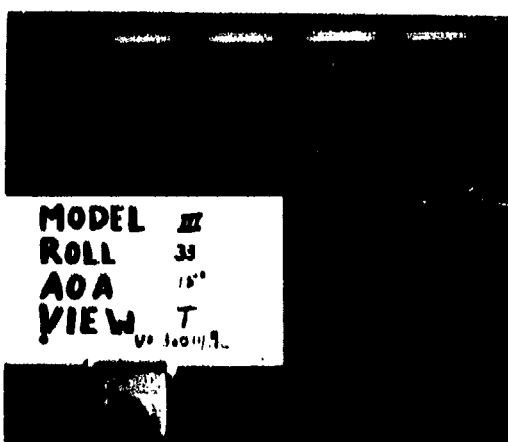


2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

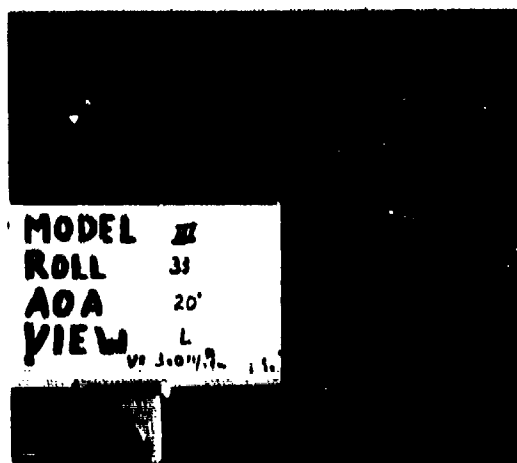
COLUMN 1. MISSILE III, 22° ROLL, 22° AOA



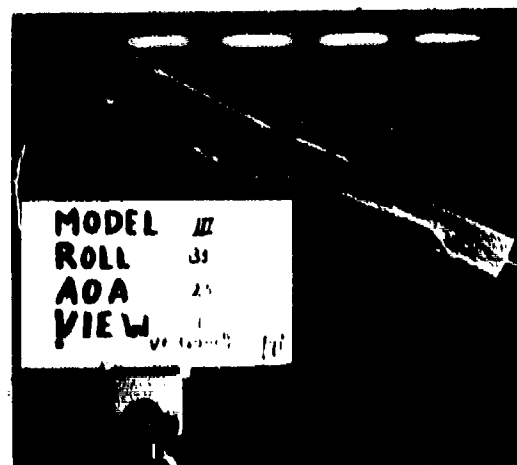
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE III, 33° ROLL, 15° AOA

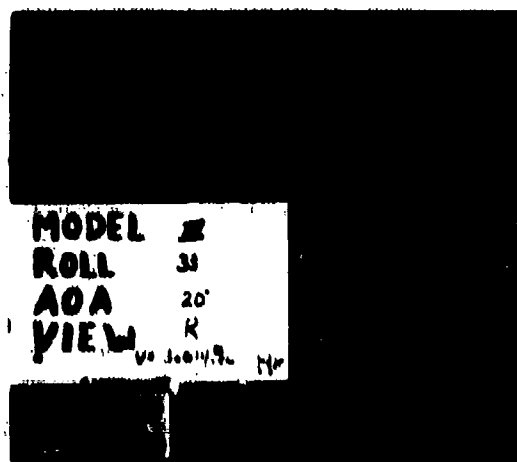
# FIGURE E-24 OIL FLOW VISUALIZATION PHOTOGRAPHS



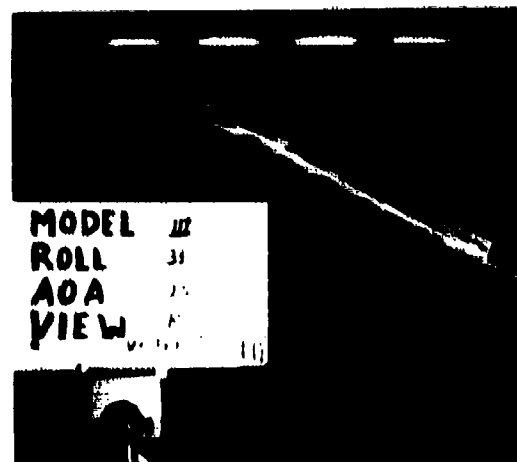
1a. PICTURE A- LEFT SIDE VIEW



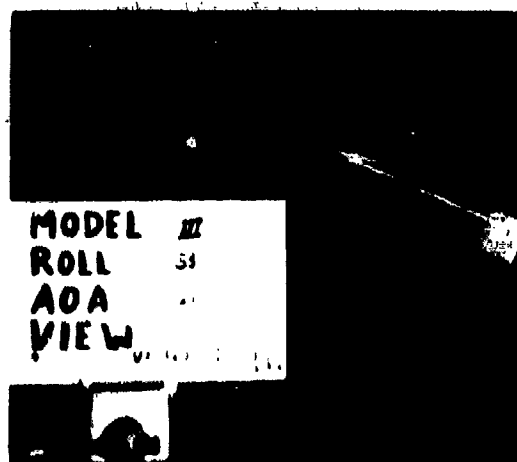
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

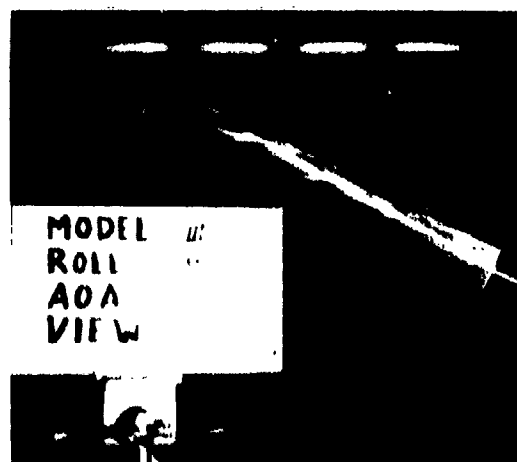


2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

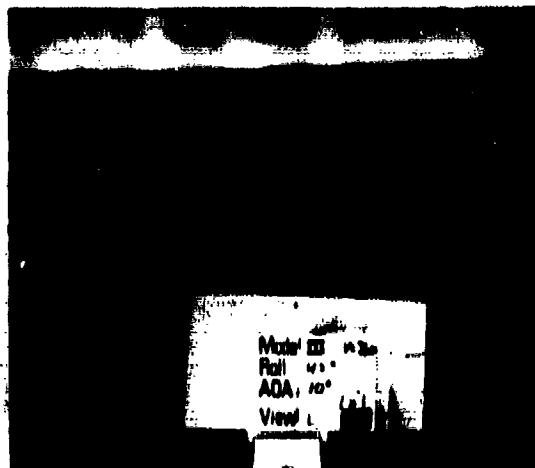
COLUMN 1. MISSILE III, 33° ROLL, 20° AOA



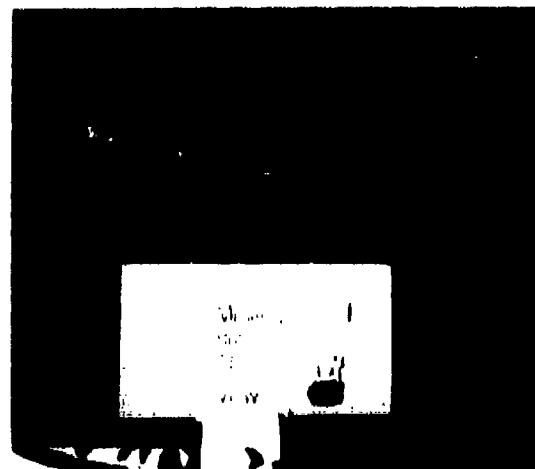
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE III, 33° ROLL, 20° AOA

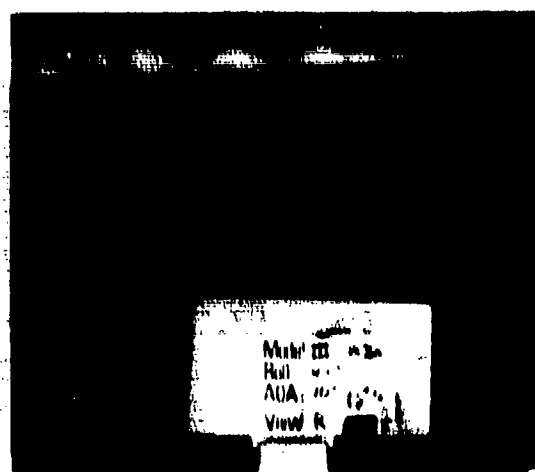
FIGURE E-25 OIL FLOW VISUALIZATION PHOTOGRAPHS



1a. PICTURE A- LEFT SIDE VIEW



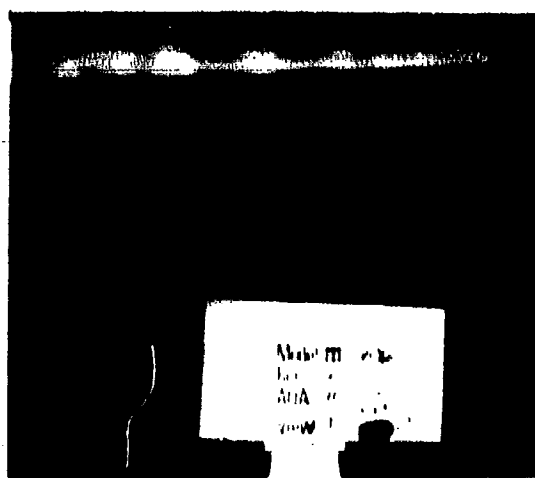
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

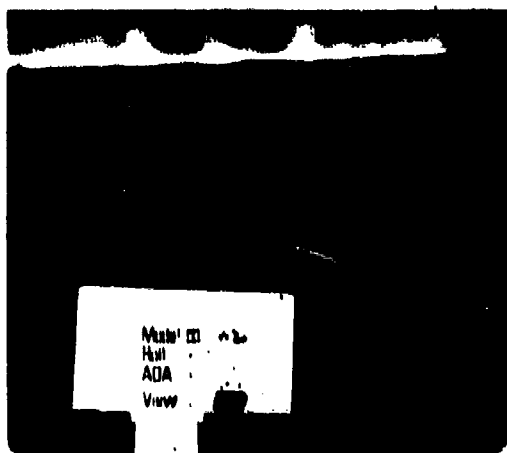
COLUMN 1. MISSILE 111, 45° ROLL, 10° AOA



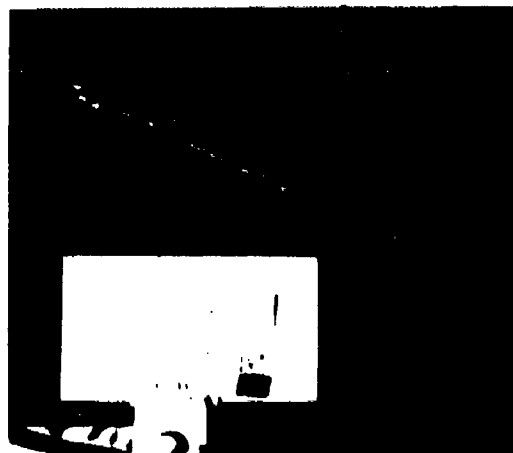
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE 111, 45° ROLL, 10° AOA

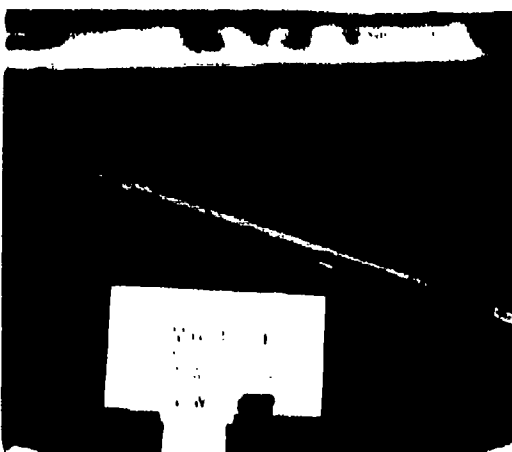
FIGURE E-26 OIL FLOW VISUALIZATION PHOTOGRAPHS



1a. PICTURE A- LEFT SIDE VIEW



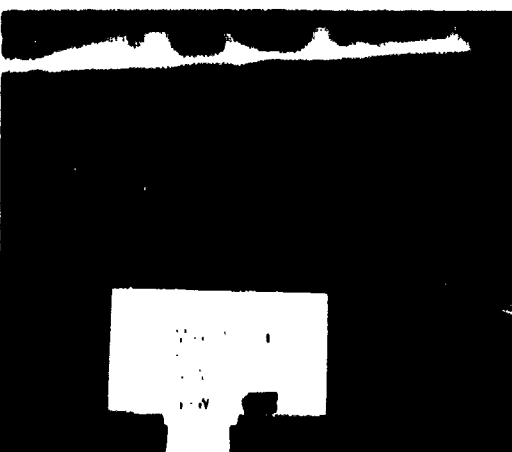
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

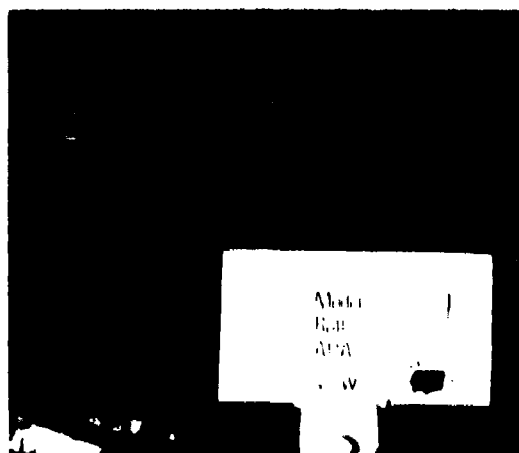


2c. PICTURE F- TOPSIDE VIEW

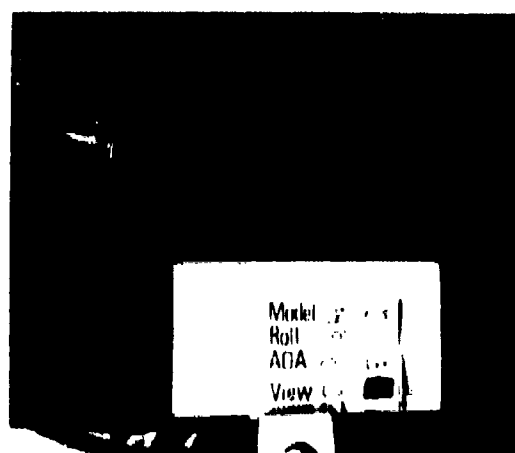
COLUMN 1. MISSILE 111, 45° ROLL, 20° AOA

COLUMN 2. MISSILE 111, 45° ROLL, 20° AOA

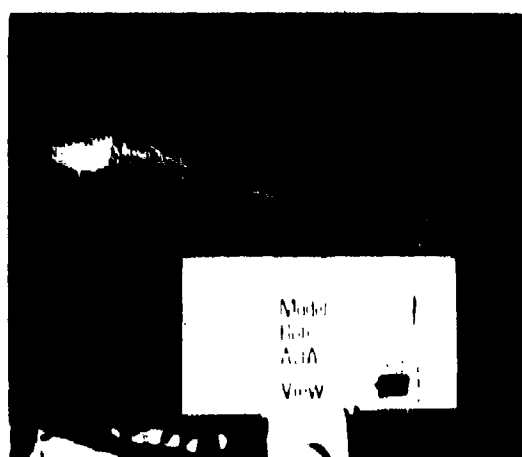
FIGURE E-27 OIL FLOW VISUALIZATION PHOTOGRAPHS



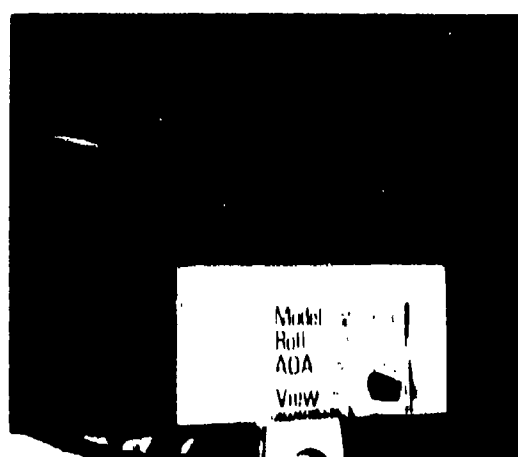
1a. PICTURE A- LEFT SIDE VIEW



2a. PICTURE D- LEFT SIDE VIEW



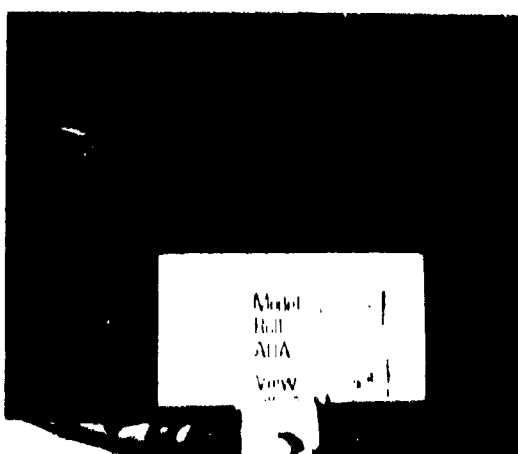
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOP SIDE VIEW

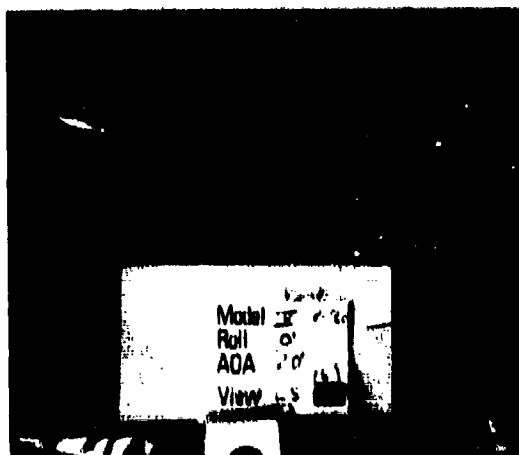


2c. PICTURE F- TOP SIDE VIEW

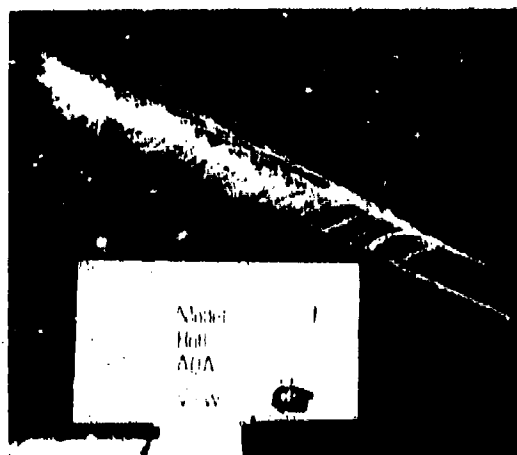
COLUMN 1, MODEL 1, ROLL 1, AOA 1

COLUMN 2, MODEL 1, ROLL 1, AOA 1

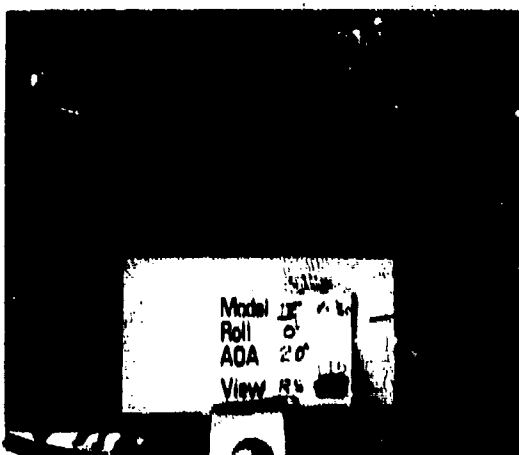
# FIGURE E-25 OIL FLOW VISUALIZATION PHOTOGRAPHS



1a. PICTURE A- LEFT SIDE VIEW



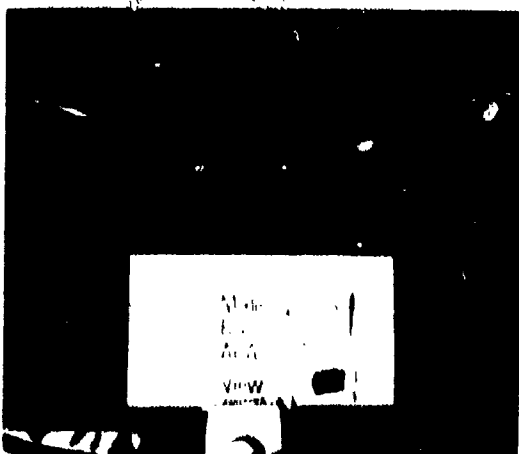
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

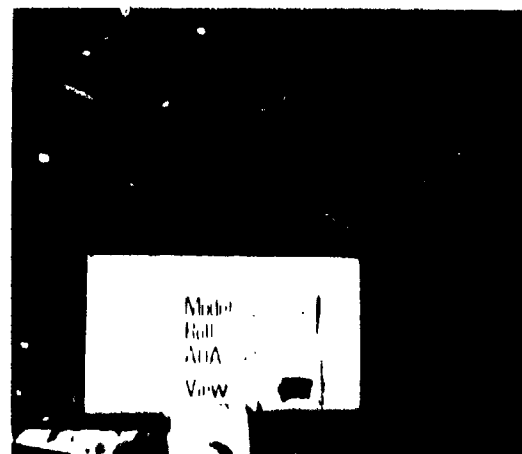


2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

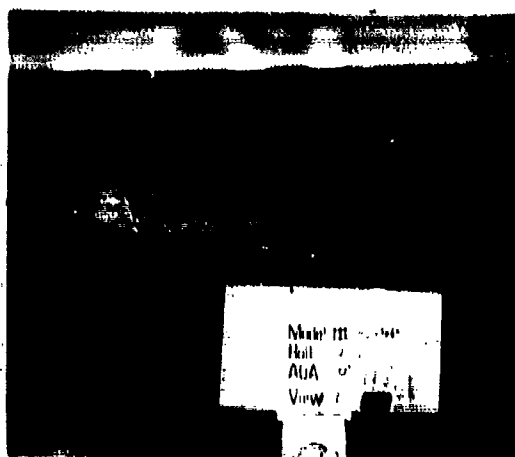
COLUMN 1. MISSILE IV, 0° ROLL, 20° AOA



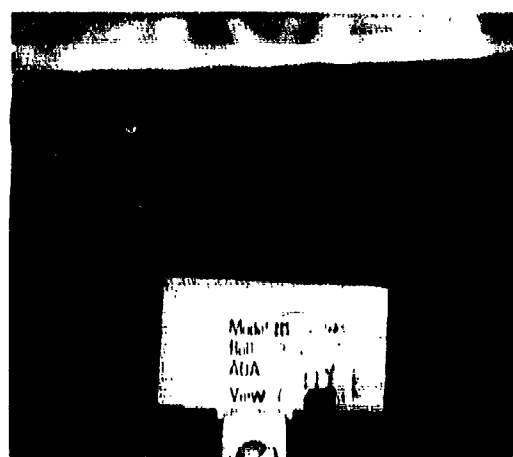
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE IV, 0° ROLL, 20° AOA

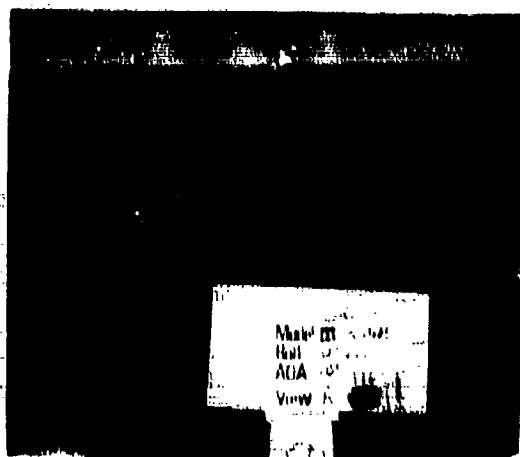
FIGURE E-29. OIL FLOW VISUALIZATION PHOTOGRAPHS



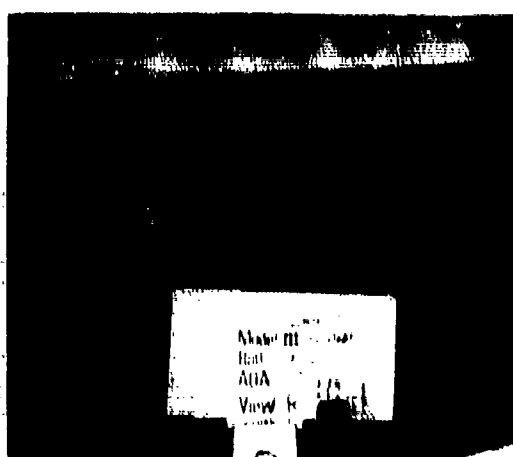
1a. PICTURE A- LEFT SIDE VIEW



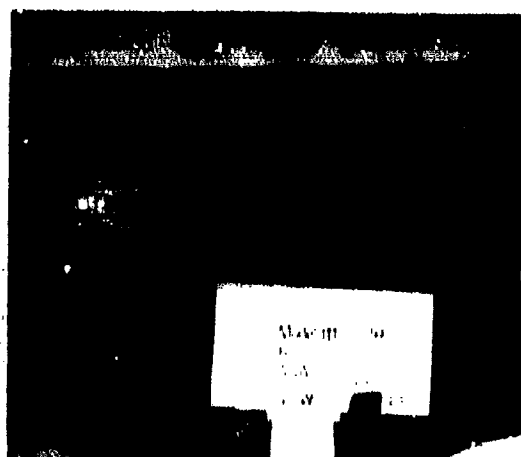
2a. PICTURE D- LEFT SIDE VIEW



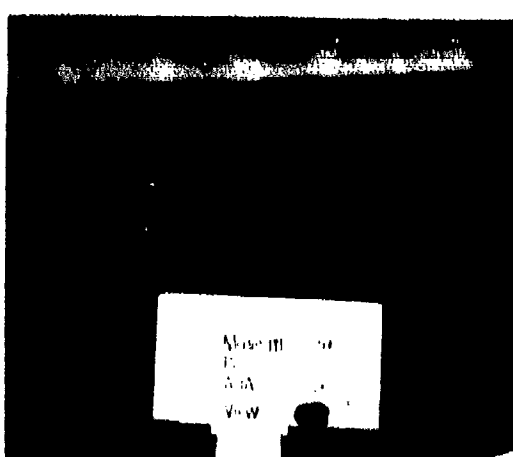
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW

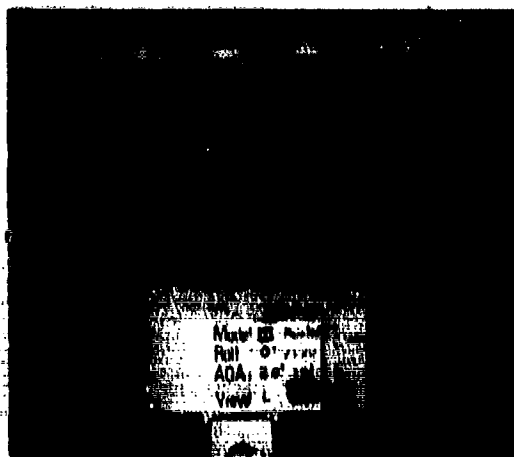


1c. PICTURE C- TOPSIDE VIEW  
COLUMN 1. MISSILE LEFT, 0° ROLL, 20° AOA

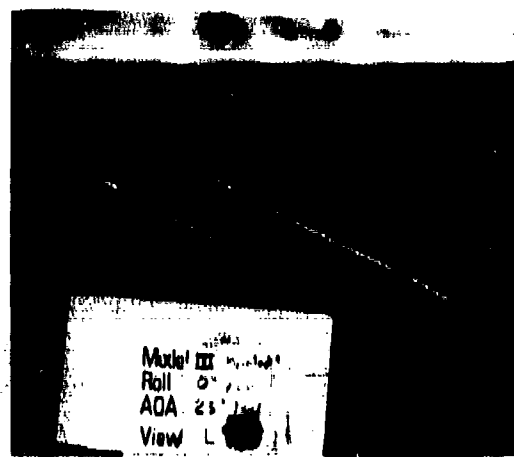


2c. PICTURE F- TOPSIDE VIEW  
COLUMN 2. MISSILE LEFT, 0° ROLL, 20° AOA

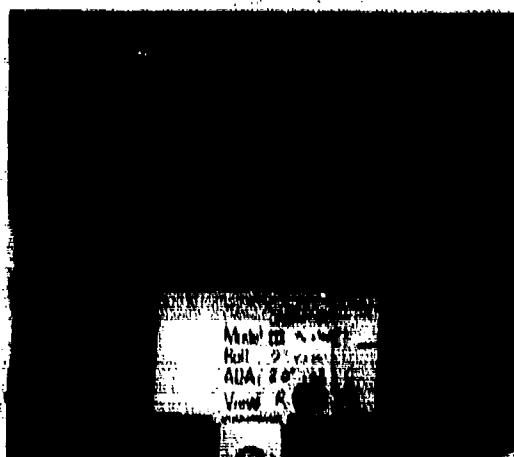
# FIGURE E-30. OIL FLOW VISUALIZATION PHOTOGRAPHS



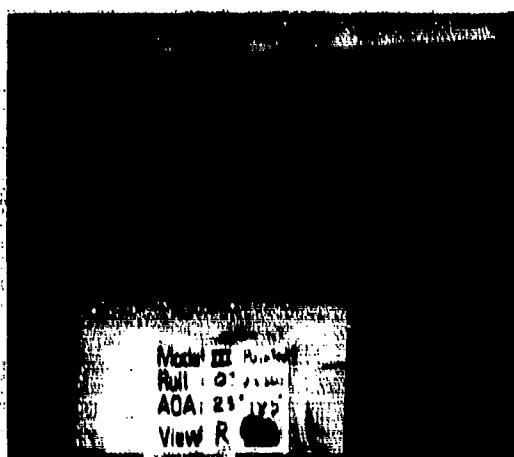
1a. PICTURE A- LEFT SIDE VIEW



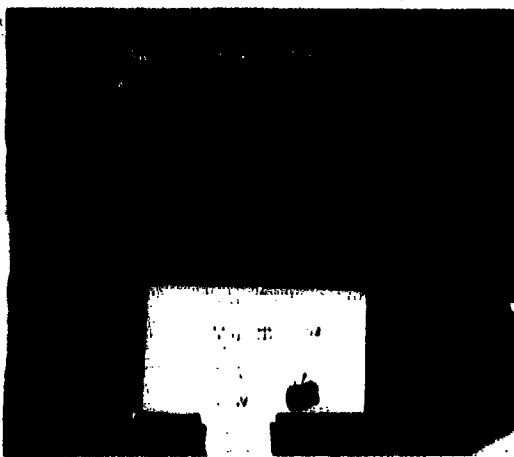
2a. PICTURE D- LEFT SIDE VIEW



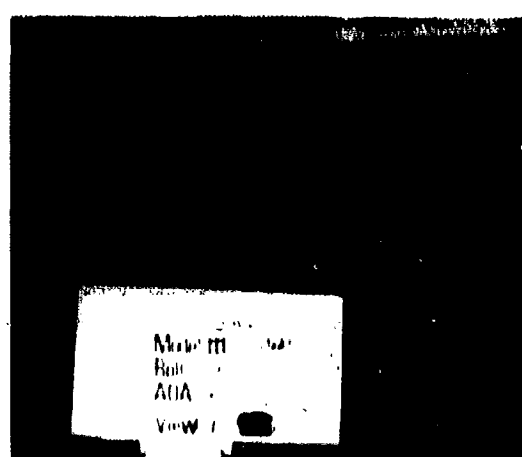
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW



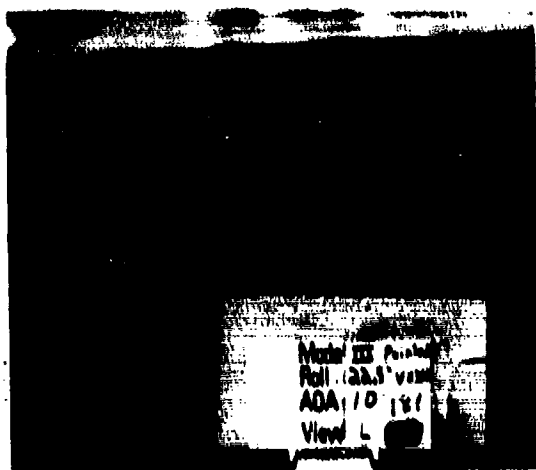
2c. PICTURE F- TOPSIDE VIEW

COMMON 1. MISSILE TIP, 0° ROLL, 20° AOA

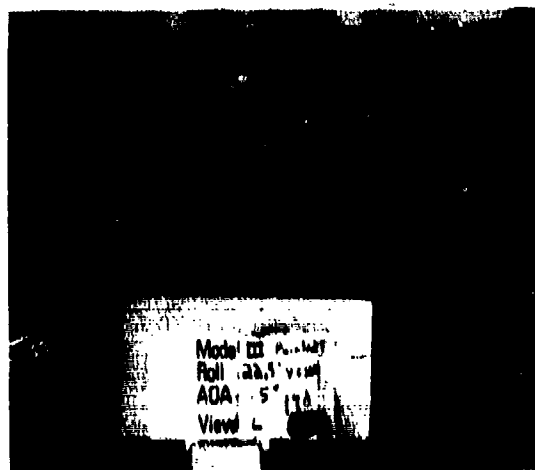
COMMON 2. MISSILE TIP, 0° ROLL, 25° AOA

# FIGURE E-31 OIL FLOW VISUALIZATION PHOTOGRAPHS

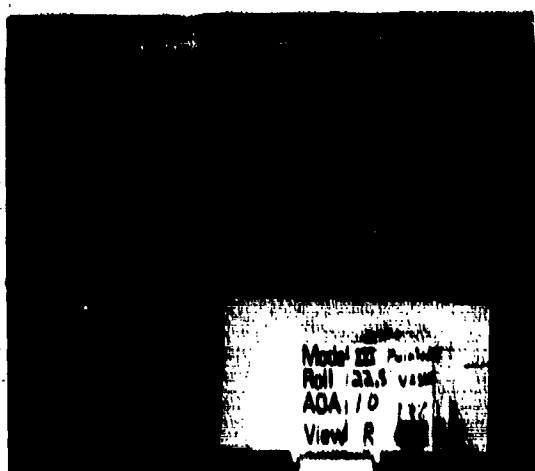




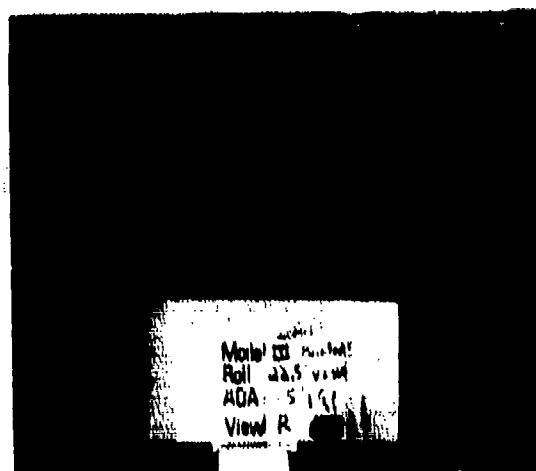
1a. PICTURE A- LEFT SIDE VIEW



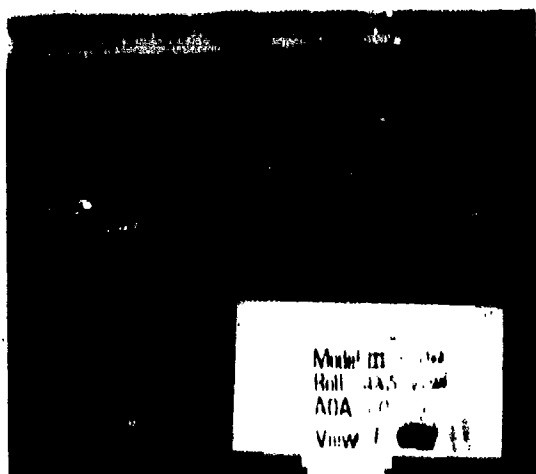
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

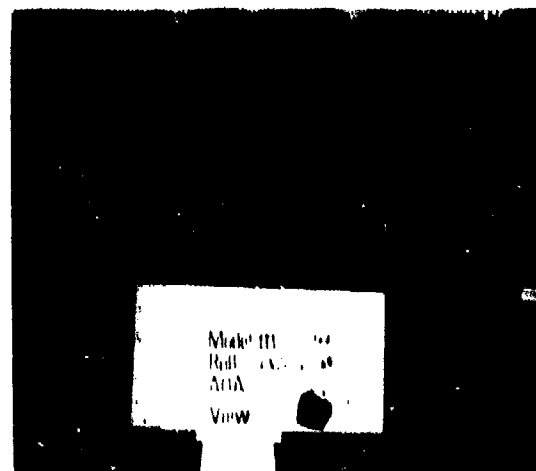


2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

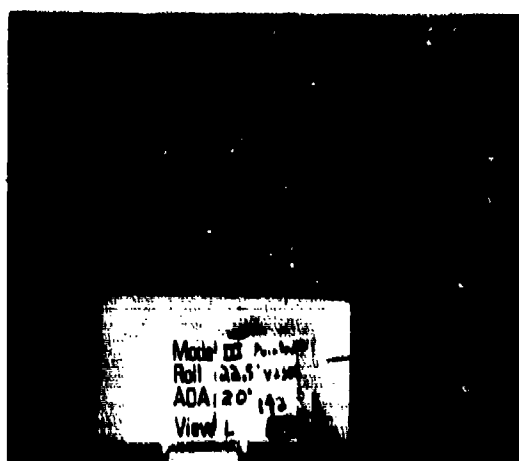
COLUMN 1. MISSILE TIP, 0° ROLL, 10° AOA



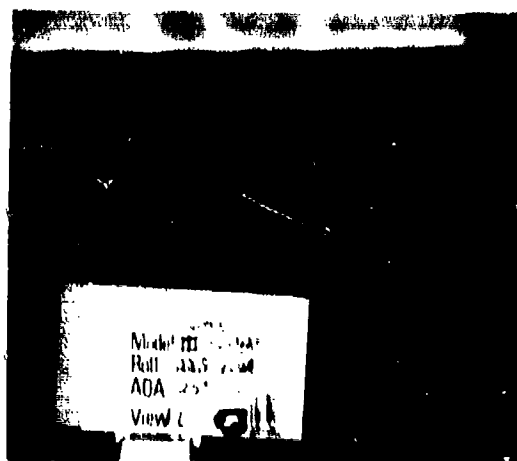
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE TIP, 0° ROLL, 10° AOA

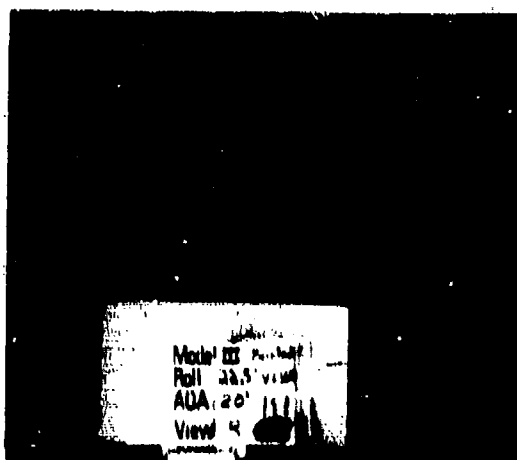
# FIGURE E-39. OIL FLOW VISUALIZATION PHOTOGRAPHS



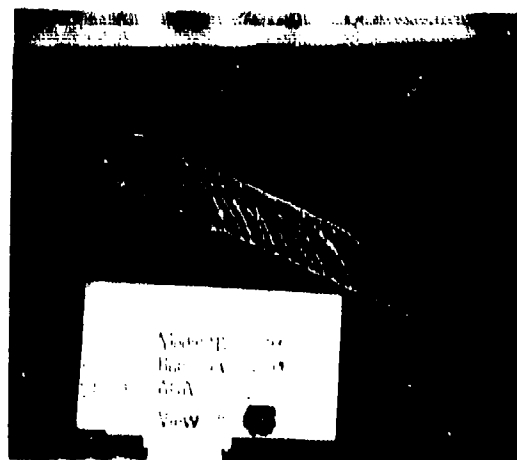
1a. PICTURE A- LEFT SIDE VIEW



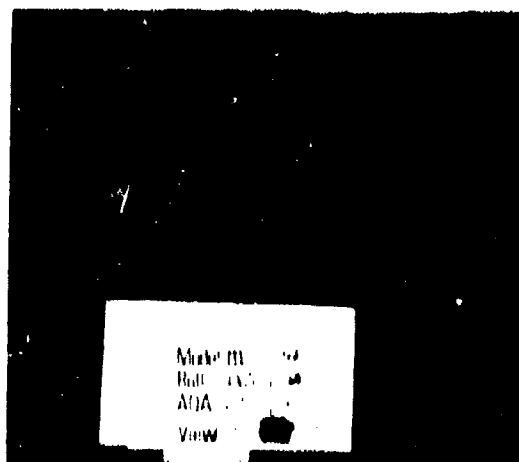
2a. PICTURE D- LEFT SIDE VIEW



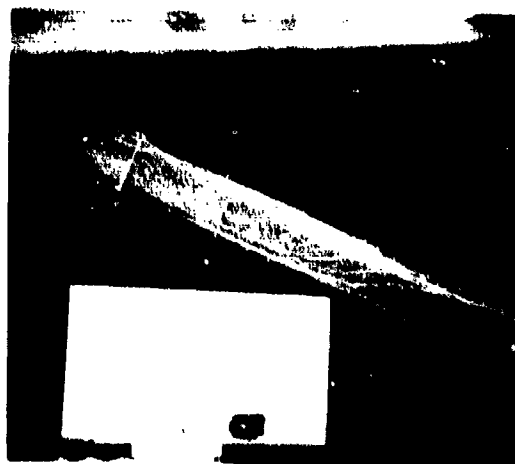
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

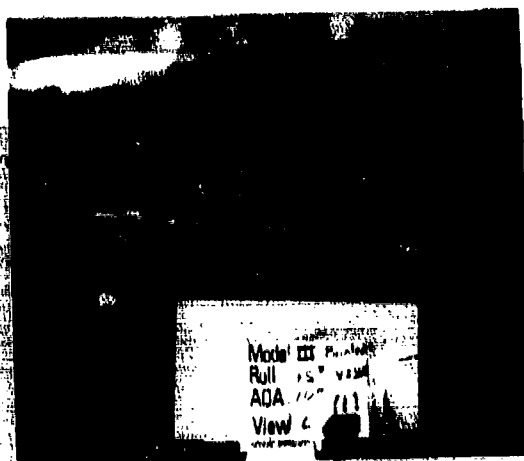


2c. PICTURE F- TOPSIDE VIEW

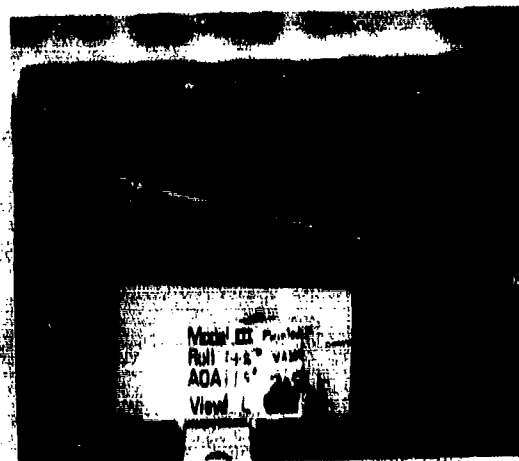
COLUMN 1. MISSILE TIP, 22° ROLL, 20° AOA

COLUMN 2. MISSILE TIP, 22° ROLL, 20° AOA

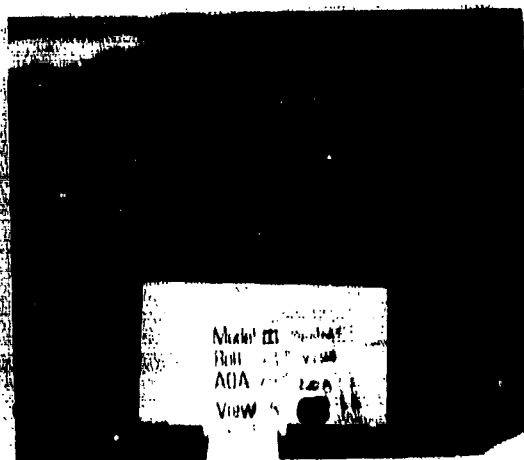
FIGURE E-33. OIL FLOW VISUALIZATION PHOTOGRAPHS



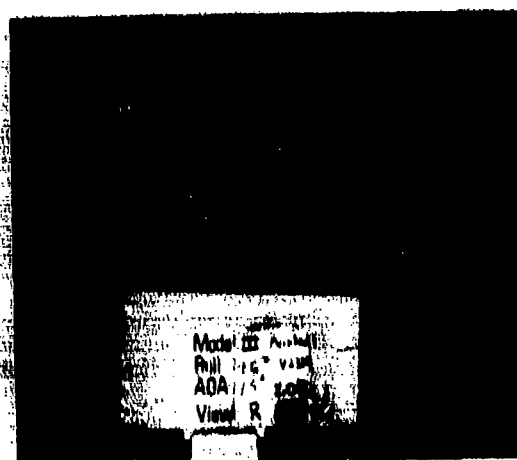
1a. PICTURE A- LEFT SIDE VIEW



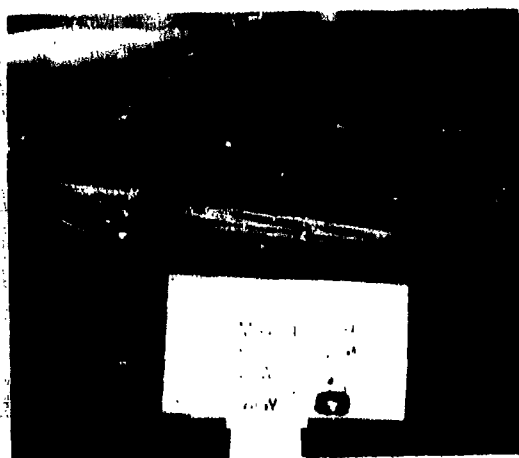
2a. PICTURE D- LEFT SIDE VIEW



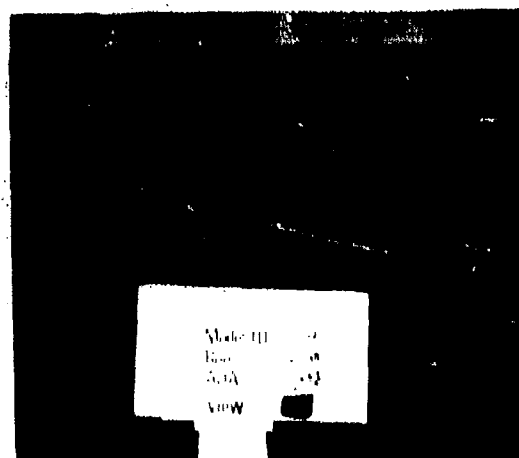
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

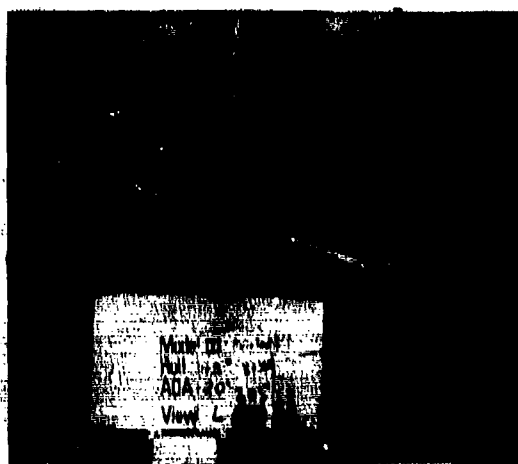


2c. PICTURE F- TOPSIDE VIEW

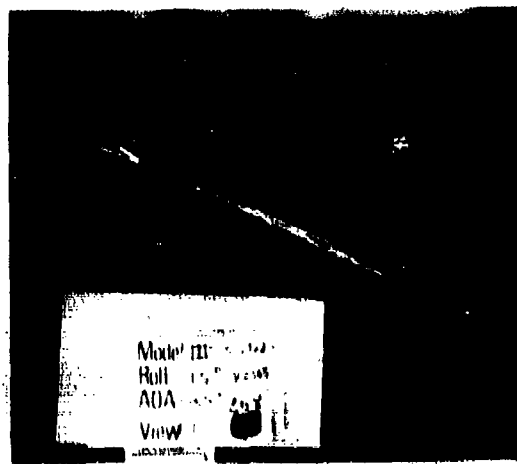
COLUMN 1. MISSILE TTP, 45° ROLL, 10° AOA

COLUMN 2. MISSILE TTP, 45° ROLL, 15° AOA

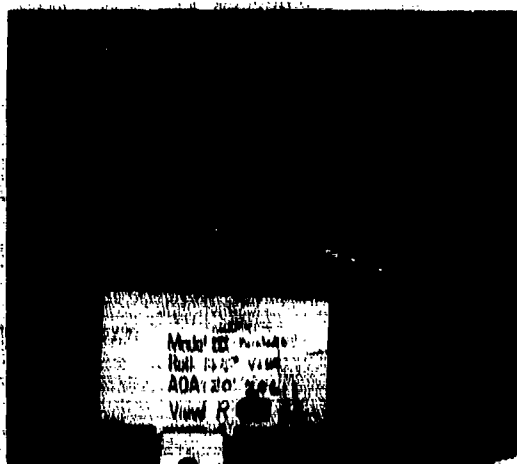
# FIGURE E-34 OIL FLOW VISUALIZATION PHOTOGRAPHS



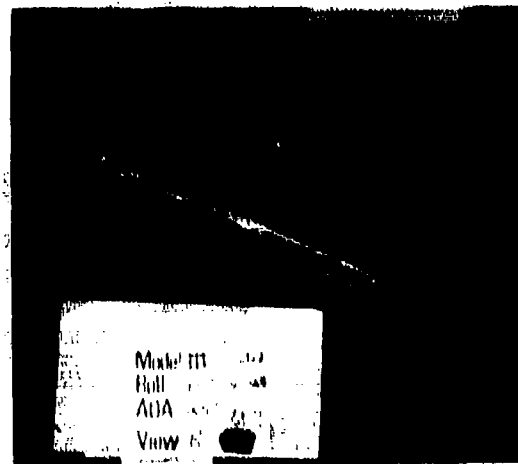
1a. PICTURE A- LEFT SIDE VIEW



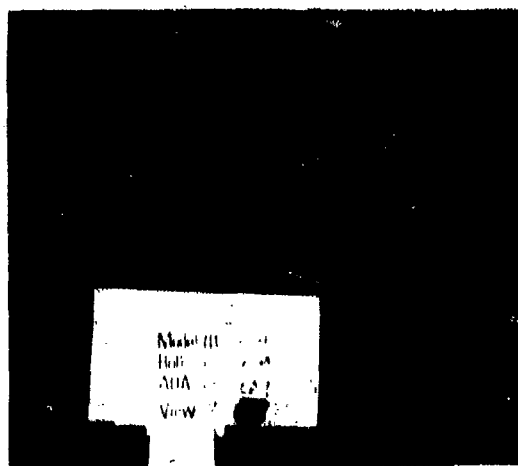
2a. PICTURE D- LEFT SIDE VIEW



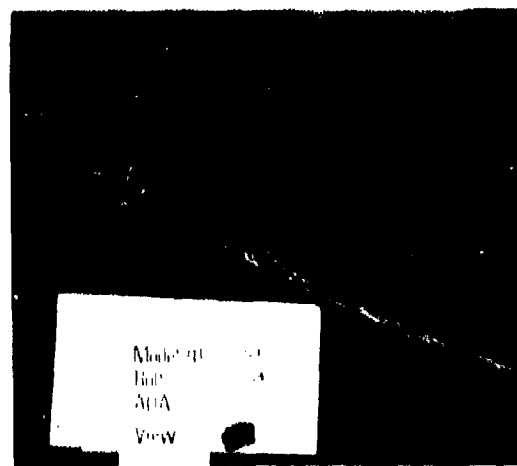
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

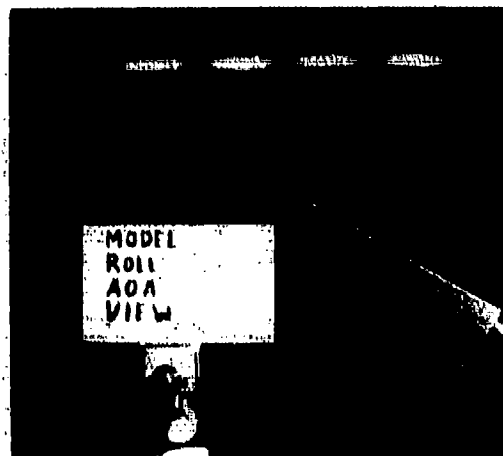
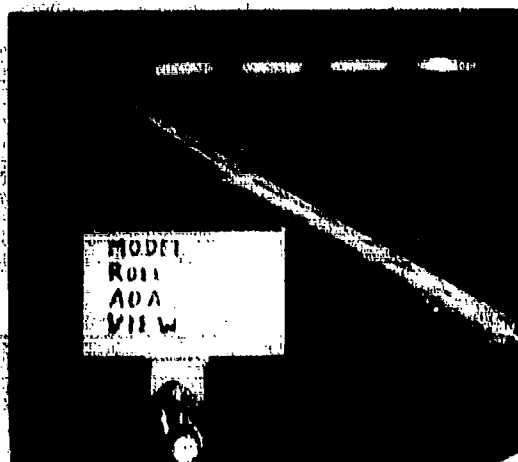
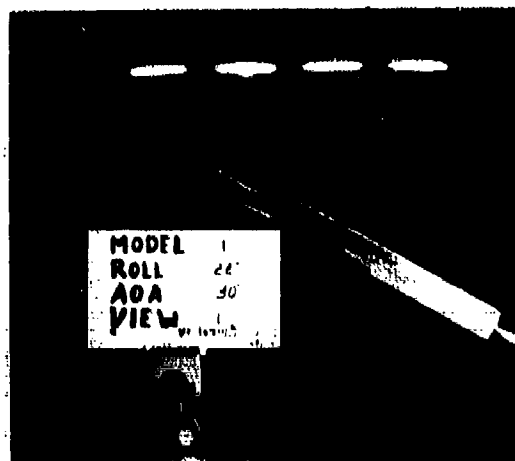
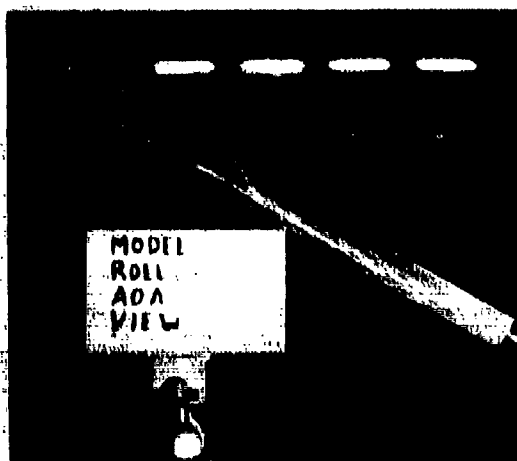


2c. PICTURE F- TOPSIDE VIEW

COLUMN 1. MISSILE TEEP, 45° ROLL, 20° AOA

COLUMN 2. MISSILE TEEP, 45° ROLL, 35° AOA

# FIGURE E-35 OIL FLOW VISUALIZATION PHOTOGRAPHS

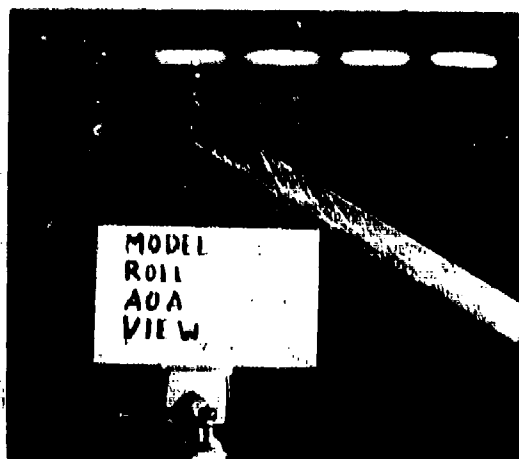


1c. PHOTOGRAPH - FRONT VIEW

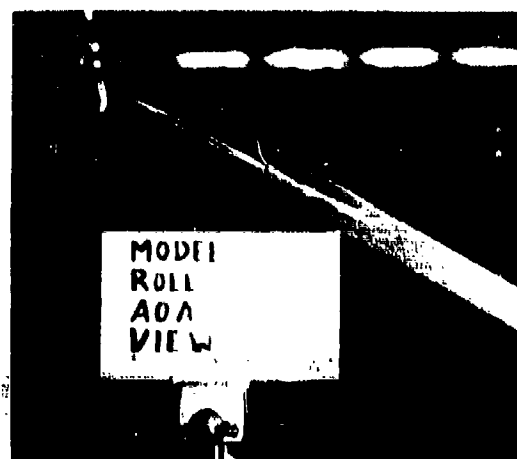
COLONN 1, MICHELLE J. O'ROURKE, DO ADA

FIG. 1. FIGURE 1. TOPSIDE VIEW

FIGURE 1-3: OIL FLOW VISUALIZATION PHOTOGRAPHS



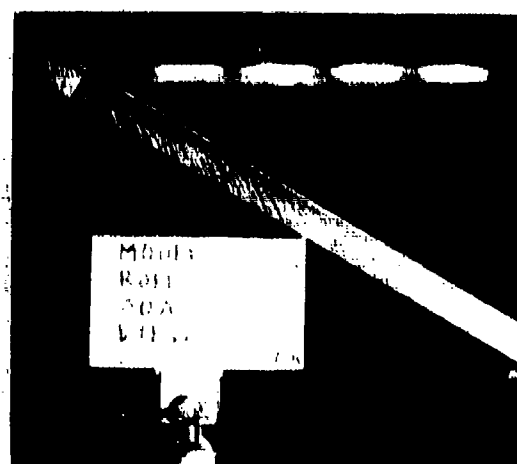
1a. PICTURE A- LEFT SIDE VIEW



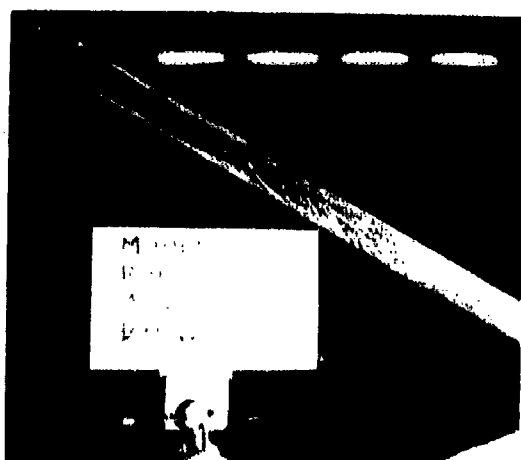
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

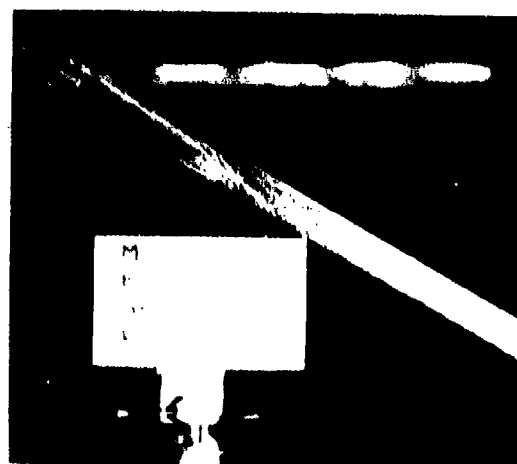


2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE G- TOPSIDE VIEW

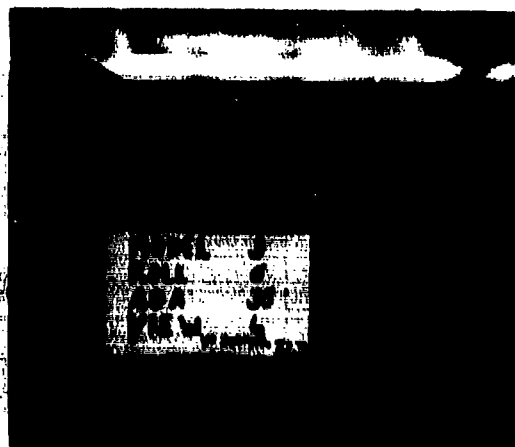
COGNITIVE MESSAGE: 1. OF ROLL, 30. AOA



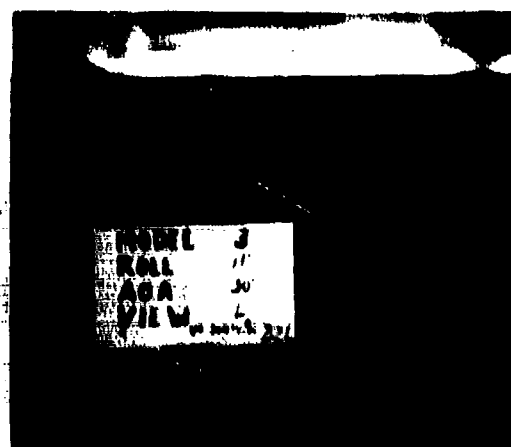
2c. PICTURE F- TOPSIDE VIEW

COGNITIVE MESSAGE: 1. OF ROLL, 30. AOA

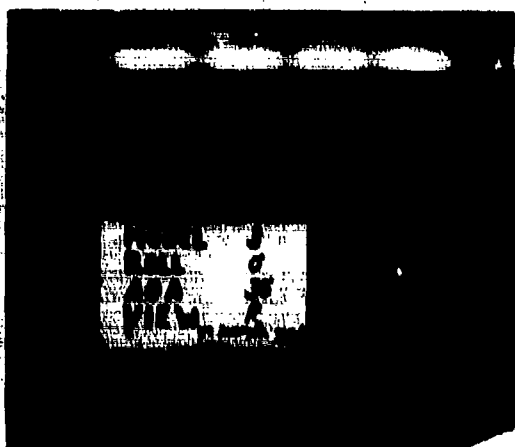
FIGURE E-37. OIL FLOW VISUALIZATION PHOTOGRAPHS



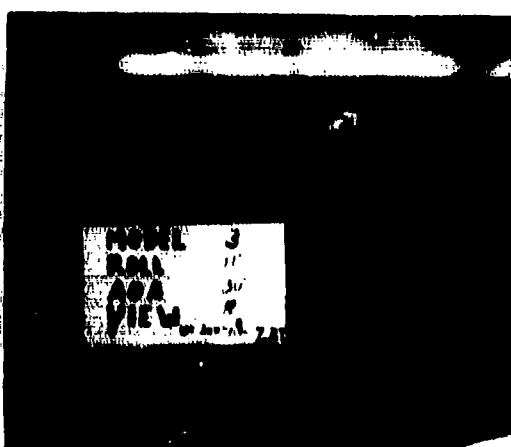
1a. PICTURE A- LEFT SIDE VIEW



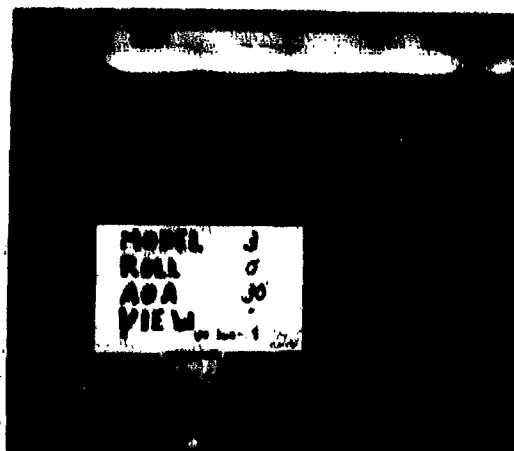
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

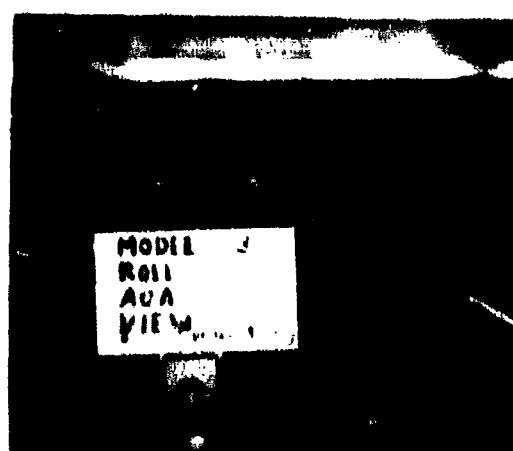


2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- INSIDE VIEW

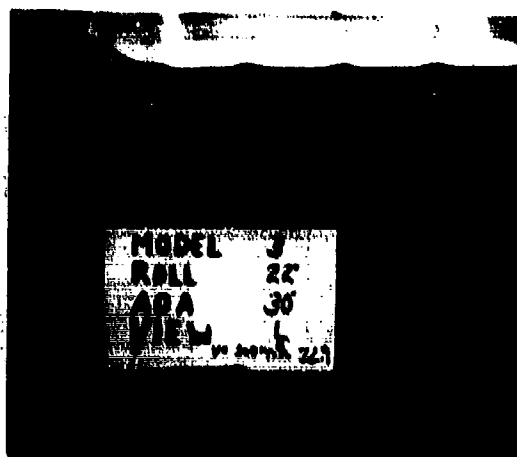
CONTINUED: MODEL 3, 11 DEGREE, 30 AOA



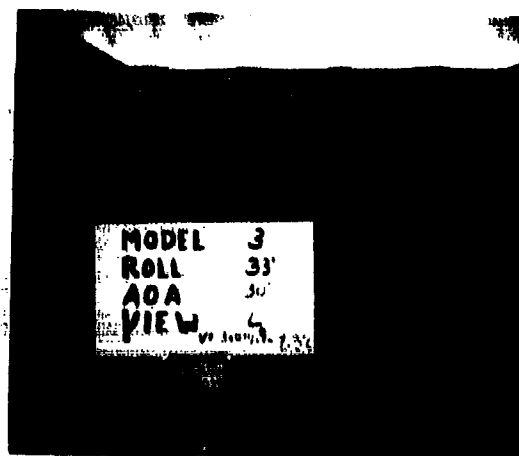
2c. PICTURE F- INSIDE VIEW

CONTINUED: MODEL 3, 11 DEGREE, 30 AOA

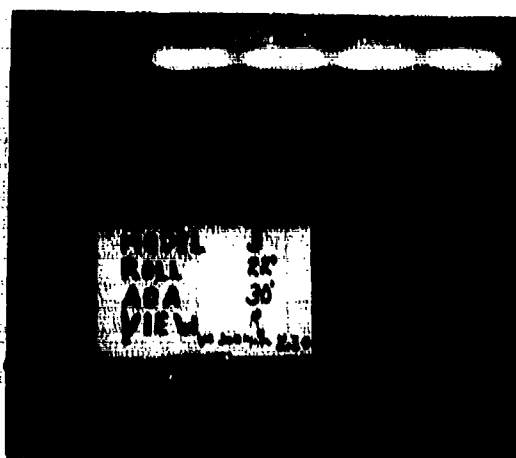
FIGURE E-38 OIL FLOW VISUALIZATION PHOTOGRAPHS



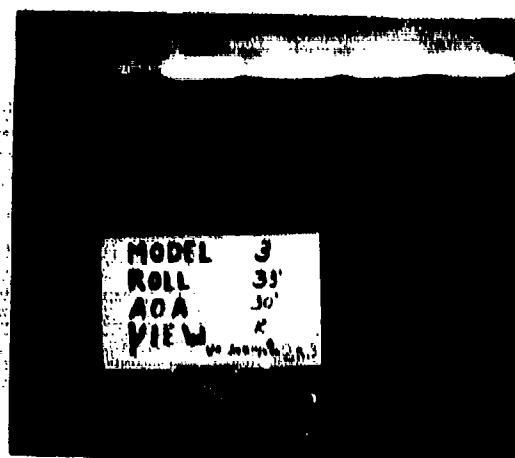
1a. PICTURE A- LEFT SIDE VIEW



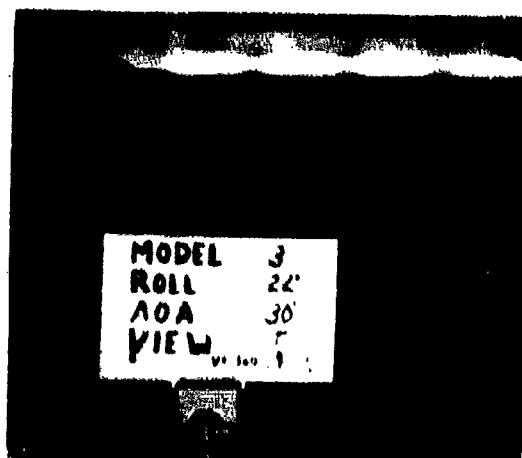
2a. PICTURE D- LEFT SIDE VIEW



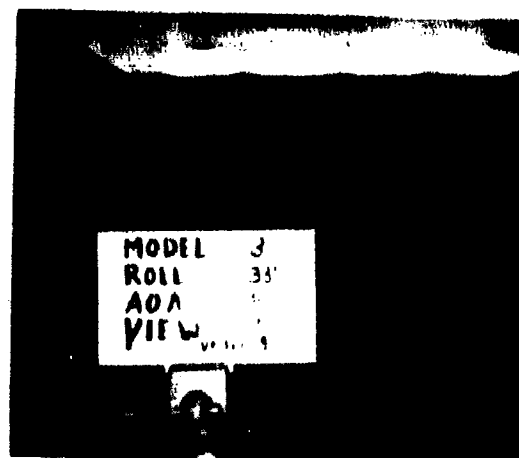
1b. PICTURE B- RIGHT SIDE VIEW



2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW



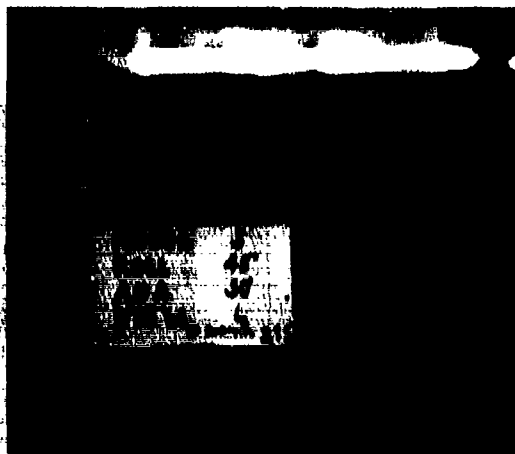
2c. PICTURE F- TOPSIDE VIEW

COLUMBIA, MISSILE 1, 22' ROLL, 30' AOA

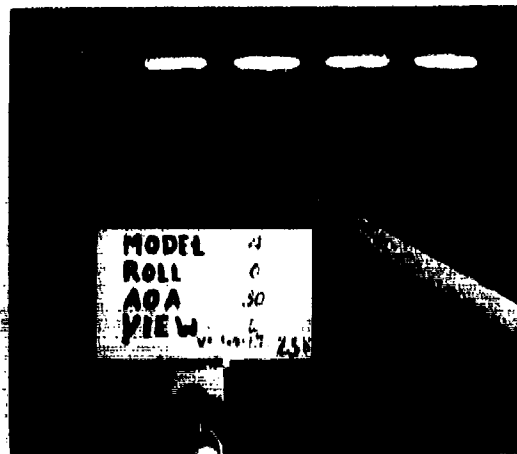
COLUMBIA, MISSILE 1, 33' ROLL, 30' AOA

FIGURE E-39 OIL FLOW VISUALIZATION PHOTOGRAPHS

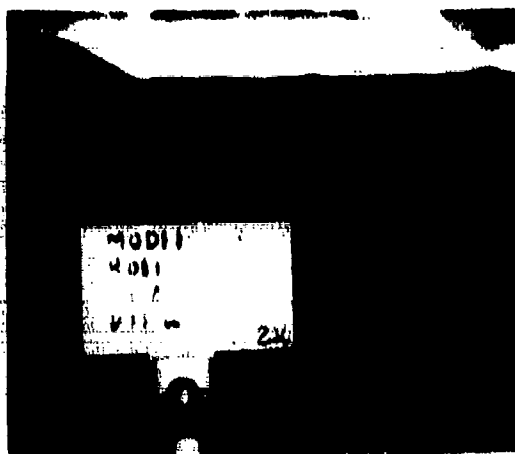




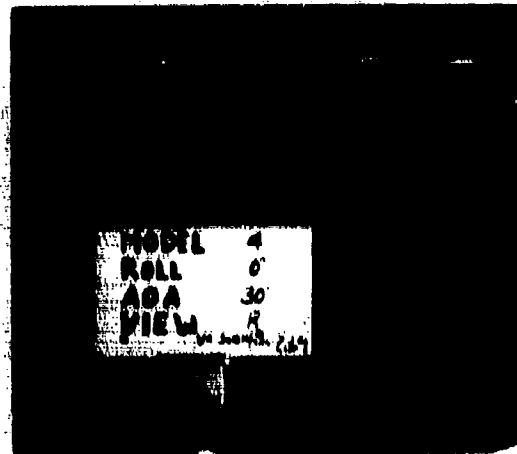
1a. PICTURE A- LEFT SIDE VIEW



2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

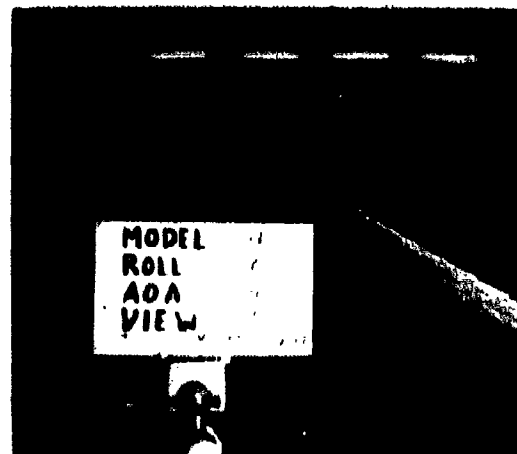


2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

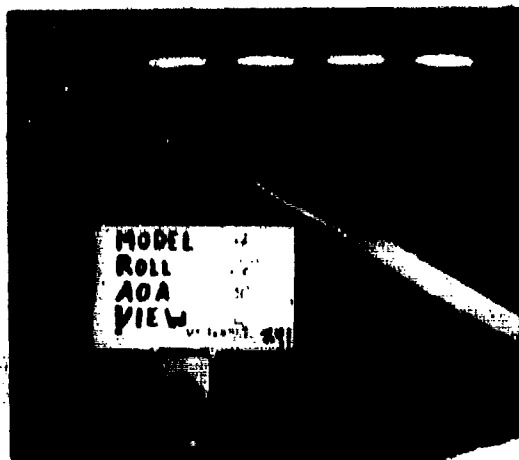
COLUMN 1. MISSILE 1, 45° ROLL, 30° AOA



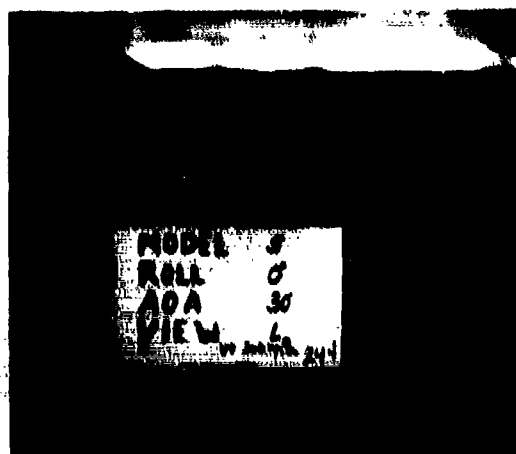
2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE 4, 0° ROLL, 30° AOA

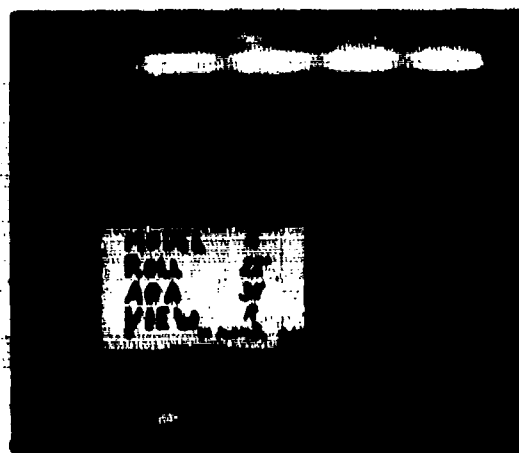
FIGURE E-40 OIL FLOW VISUALIZATION PHOTOGRAPHS



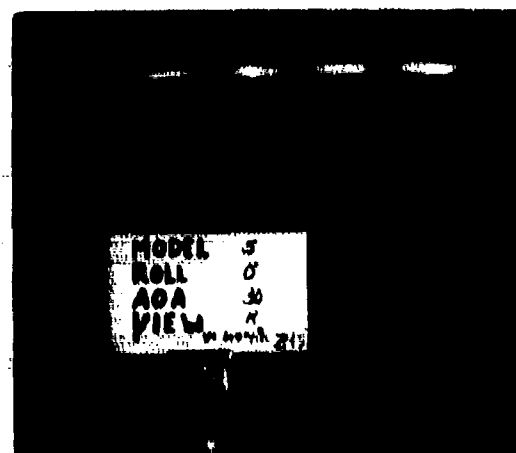
1a. PICTURE A- LEFT SIDE VIEW



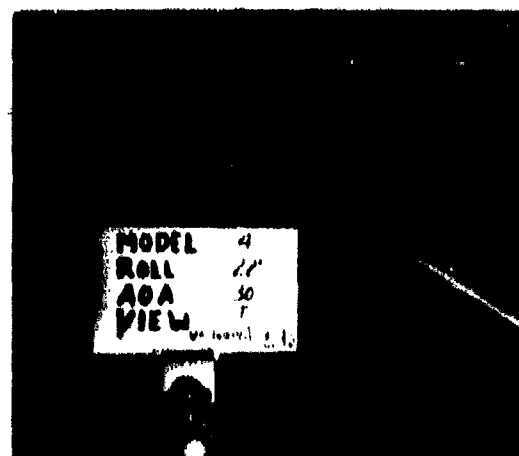
2a. PICTURE D- LEFT SIDE VIEW



1b. PICTURE B- RIGHT SIDE VIEW

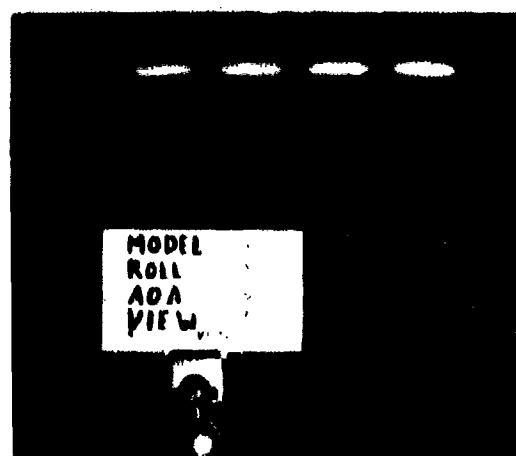


2b. PICTURE E- RIGHT SIDE VIEW



1c. PICTURE C- TOPSIDE VIEW

COLUMN 1. MISSILE 4, 22" ROLL, 30" AOA



2c. PICTURE F- TOPSIDE VIEW

COLUMN 2. MISSILE 5, 0" ROLL, 30" AOA

# FIGURE E-41. OIL FLOW VISUALIZATION PHOTOGRAPHS

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